

DRAFT  
SAMPLING AND ANALYSIS PLAN  
ADDITIONAL REMEDIAL INVESTIGATION  
FOR THE TAYLOR BOULEVARD BRIDGE  
(SITE 30) AND THE TIDAL AREA  
LANDFILL (SITE 01)  
Naval Weapons Station Seal Beach Detachment  
Concord, California

**December 20, 2002**

Prepared for



DEPARTMENT OF THE NAVY  
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Prepared by



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Draft

**Sampling and Analysis Plan  
Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and  
the Tidal Area Landfill (Site 01)**

**Delivery Order 045**

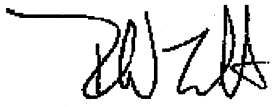
**Prepared for:**

**DEPARTMENT OF THE NAVY**

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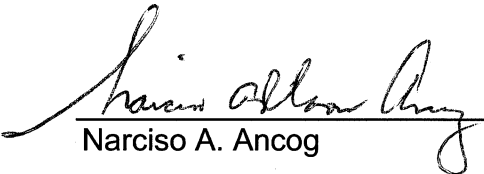
**REVIEW AND APPROVAL**

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**TABLE 1: ELEMENTS OF EPA QA/R-5 IN RELATION TO THIS SAP**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

<b>EPA QA/R-5 QAPP ELEMENT<sup>a</sup></b>		<b>Tetra Tech SAP</b>
A1	Title and Approval Sheet	Title and Approval Sheet
A2	Table of Contents	Table of Contents
A3	Distribution List	Distribution List
A4	Project/Task Organization	1.4 Project Organization
A5	Problem Definition/Background	1.1 Problem Definition and Background
A6	Project/Task Description	1.2 Project Description
A7	Quality Objectives and Criteria	1.3 Quality Objectives and Criteria
A8	Special Training/Certification	1.5 Special Training and Certification
A9	Documents and Records	1.6 Documents and Records
B1	Sampling Process Design	2.1 Sampling Process Design
B2	Sampling Methods	2.2 Sampling Methods
B3	Sample Handling and Custody	2.3 Sample Handling and Custody
B4	Analytical Methods	2.4 Analytical Methods
B5	Quality Control	2.5 Quality Control
B6	Instrument/Equipment Testing, Inspection, and Maintenance	2.6 Equipment Testing, Inspection, and Maintenance
B7	Instrument/Equipment Calibration and Frequency	2.7 Instrument Calibration and Frequency
B8	Inspection/Acceptance of Supplies and Consumables	2.8 Inspection and Acceptance of Supplies and Consumables
B9	Non-direct Measurements	2.9 Nondirect Measurements
B10	Data Management	2.10 Data Management
C1	Assessment and Response Actions	3.1 Assessment and Response Actions
C2	Reports to Management	3.2 Reports to Management
D1	Data Review, Verification, and Validation	4.1 Data Review, Verification, and Validation
D2	Validation and Verification Methods	
D3	Reconciliation with User Requirements	4.2 Reconciliation with User Requirements

Notes:

a EPA. 2001. "EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5." Office of Environmental Information. Washington, D.C. EPA/240/B-01/003. March.

EPA U.S. Environmental Protection Agency

QAPP Quality assurance project plan

SAP Sampling and analysis plan

Tetra Tech Tetra Tech EM Inc.

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## ACRONYMS AND ABBREVIATIONS

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AECRU	Architect-Engineer CERCLA/RCRA/UST Contract
AWQC	Ambient Water Quality Criteria
bgs	Below ground surface
CFR	<i>Code of Federal Regulations</i>
CLP	Contract laboratory program
COPC	Contaminant of potential concern
CPR	Cardiopulmonary resuscitation
DHS	California Department of Health Services
DO	Delivery Order
DQA	Data quality assessment
DQO	Data quality objective
E&E	Ecology and Environment, Inc.
EDD	Electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
ER	Equipment rinsate
ERA	Environmental risk assessment
FSP	Field sampling plan
FTL	Field team leader
GC/MS	Gas chromatography and mass spectrometry
HASP	Health and safety plan
ID	Identification
IDL	Instrument detection limit
IDW	Investigation-derived waste
ICP	Inductively coupled plasma
IRCDQM	“Installation Restoration Chemical Data Quality Manual”
IT	International Technology Corporation
L	Liter
L/min	Liter per minute
LCS	Laboratory control sample
LIMS	Laboratory information management system

## ACRONYMS AND ABBREVIATIONS (Continued)

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MDL	Method detection limit
µg/L	Microgram per liter
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mL	Milliliter
MQO	Measurement quality objective
MS	Matrix spike
MSD	Matrix spike duplicate
MSR	Monthly status report
NWSSB	Naval Weapons Station Seal Beach
NEDD	Navy Electronic Data Deliverable
NFESC	Naval Facilities Engineering Service Center
OSHA	Occupational Safety and Health Administration
PARCC	Precision, accuracy, representativeness, completeness, and comparability
PAS	Pacific Aerial Surveys
PE	Performance evaluation
PPE	Personal protective equipment
PRC	PRC Environmental Management, Inc.
PRG	Preliminary remediation goal
PRRL	Project-required reporting limit
PVC	Polyvinyl chloride
QA	Quality assurance
QAPP	Quality assurance project plan
QC	Quality control
QCSR	Quality Control summary report
%R	Percent recovery
RI	Remedial investigation
RPD	Relative percent difference
RPM	Remedial project manager
RWQCB	Regional Water Quality Control Board
SAP	Sampling and analysis plan
SDG	Sample delivery group
SOP	Standard operating procedure
SOW	Statement of work
SQL	Sample quantitation limit

## ACRONYMS AND ABBREVIATIONS (Continued)

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SVOA	Semivolatile organic analysis
SVOC	Semivolatile organic compound
SWDIV	Naval Facilities Engineering Command, Southwest Division
TA	Tidal Area
TBB	Taylor Boulevard Bridge
TPH	Total petroleum hydrocarbons
TPH-e	Extractable total petroleum hydrocarbons
TPH-p	Purgeable total petroleum hydrocarbons
TOC	Total organic carbon
TSA	Technical systems audit
Tetra Tech	Tetra Tech EM Inc.
VOA	Volatile organic analysis
VOC	Volatile organic compound
WET	Waste extraction test

## 1.0 PROJECT DESCRIPTION AND MANAGEMENT

Tetra Tech EM Inc. (Tetra Tech) received delivery order (DO) 045 from the Department of the Navy, Naval Facilities Engineering Command, Engineering Field Activity West under the Architect-Engineer CERCLA/RCRA/UST (AECRU) Contract. Under DO 045, Tetra Tech supports an additional remedial investigation (RI) for the Tidal Area Landfill (Site 01) and the Taylor Boulevard Bridge (TBB) (Site 30) at Naval Weapons Station, Seal Beach Detachment Concord (NWSSB Detachment Concord), Concord, California. To guide the field, laboratory, and data reporting efforts associated with this project, Tetra Tech prepared this sampling and analysis plan (SAP), consisting of a field sampling plan (FSP) and a quality assurance project plan (QAPP) in an integrated format.

[Table 1](#) follows the approval page at the beginning of this SAP. The table demonstrates how this SAP addresses all the elements of a QAPP currently required by the U.S. Environmental Protection Agency (EPA) QA/R-5 guidance document ([EPA 2001](#)).

Tables and figures follow the first page on which each is mentioned in the text of this document. [Appendix A](#) contains method precision and accuracy goals, [Appendix B](#) contains standard operating procedures (SOP), [Appendix C](#) contains all field forms, [Appendix D](#) lists project-required reporting limits, [Appendix E](#) lists laboratories that Tetra Tech has contracted to analyze samples collected under Navy contracts, and [Appendix F](#) contains a determination of trace metals at water quality criteria levels.

### 1.1 PROBLEM DEFINITION AND BACKGROUND

This section describes the following:

- Purpose of the Investigation ([Section 1.1.1](#))
- Problem to be Solved ([Section 1.1.2](#))
- Facility Background ([Section 1.1.3](#))
- Site Description ([Section 1.1.4](#))
- Physical Setting ([Section 1.1.5](#))
- Summary of Previous Investigations ([Section 1.1.6](#))
- Principal Decision-Makers ([Section 1.1.7](#))
- Technical or Regulatory Standards ([Section 1.1.8](#))

### **1.1.1 Purpose of the Investigation**

The purpose of the additional RI at Site 30 is to (1) characterize groundwater quality and (2) determine the vertical extent of debris, and 3) determine metal concentrations in sediment beneath the debris. This additional data will supplement the information compiled in the draft final RI report ([Tetra Tech 2002](#)) and will be summarized in a letter report. The primary purpose of the additional RI at Site 01 is to address whether leachate from the landfill has migrated to groundwater. In 1998, when groundwater was last sampled ([Tetra Tech 1998a](#)), leachate from the landfill was not detected in the groundwater. The results of the Site 01 RI will be summarized in a letter report.

### **1.1.2 Problem to be Solved**

Groundwater quality and the vertical extent of the debris at Site 30 have not been characterized. Groundwater samples will be collected to evaluate whether site-related chemicals have migrated to groundwater and adversely affected groundwater quality. The vertical extent of the debris will also be determined. At Site 01, the purpose of the RI is to confirm that formation and migration of leachate from the landfill has not occurred since groundwater was last sampled in 1998. The field activities described in Sections 1.1.2.1 and 1.1.2.2 will be carried out at Site 30 and Site 01 to meet these objectives.

#### **1.1.2.1 Site 30 – Taylor Boulevard Bridge Disposal Area**

Three monitoring wells will be installed. Samples will be collected from the wells to assess groundwater quality within the vicinity of Site 30. Two rounds of groundwater samples will be collected. Samples will be filtered and analyzed for dissolved metals and pH.

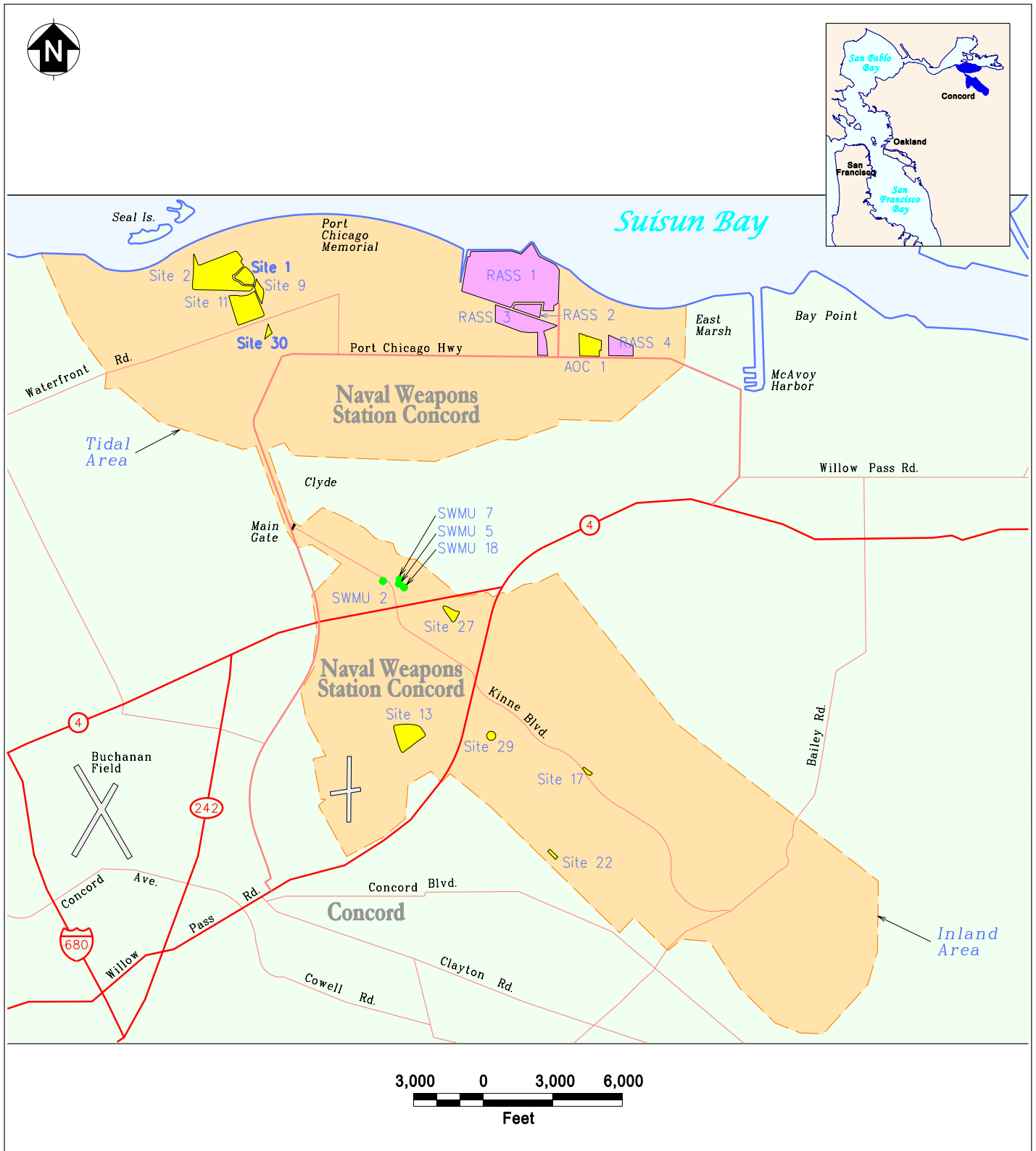
Five discrete core samples will be collected to delineate the vertical extent of the debris at Site 30. Sediment samples will be collected from the bottom of each debris core and analyzed for metals, pH, and total organic carbon (TOC).

#### **1.1.2.2 Site 01 – Tidal Area Landfill**

One groundwater sample will be collected from each of the seven existing monitoring wells in the Tidal Area Landfill. Groundwater samples will be analyzed for volatile organic compounds (VOC), semivolatile organic compounds (SVOC), metals, and total petroleum hydrocarbons (TPH).

### **1.1.3 Facility Background**

NWSSB Detachment Concord is located in north-central Contra Costa County, approximately 30 miles northeast of San Francisco, California. NWSSB Detachment Concord is a federally owned facility and is currently operated and maintained by the Navy. The primary function of the facility is explosive ordnance transshipment. The facility encompasses about 13,000 acres and is bounded by Suisun Bay to the north and the city of Concord to the south and west (see [Figure 1](#)).



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**FIGURE 1  
TIDAL AREA  
INLAND INVESTIGATION SITES**

SAP FOR ADDITIONAL REMEDIAL INVESTIGATION  
FOR THE TAYLOR BOULEVARD BRIDGE (SITE 30)  
AND TIDAL AREA LANDFILL (SITE 01)

Currently, the facility includes three principal areas: the Tidal Area, the Inland Area, and a radiography facility in Pittsburg, California. The Tidal Area encompasses about 6,800 acres (see [Figure 1](#)), the majority of which is wetlands. Both Sites 01 and 30 are located in the Tidal Area, which is currently being operated by the U.S. Army.

#### **1.1.4 Site Description**

The following paragraphs provide a brief site description for Site 30 and Site 01.

##### **1.1.4.1 Site 30 – Taylor Boulevard Bridge**

Site 30, a triangular-shaped area of less than 1 acre, is located beneath the Taylor Boulevard Bridge. Site 30 is bordered by wetlands to the south and west (see [Figure 2](#)) and is adjacent to Seal Creek Marsh, which is mostly open water, although the water depth varies seasonally.

Seven aerial photographs taken by Pacific Aerial Surveys (PAS) between 1952 and 1984 ([PAS 1952, 1959, 1974, and 1984](#)) and more observations made during recent site visits ([PRC Environmental Management, Inc. \[PRC\] 1996](#)) suggest that Site 30 has not been graded for more than 45 years. Slight changes can be seen in each of the photographs, but there is no evidence of grading. The Taylor Boulevard Bridge and the railroad bridge (immediately east of the Site 30) were constructed some time between 1939 and 1950. Changes in vegetation over time are apparent on the photographs, but these changes may be seasonal. The most notable change over time is the variation in the degree of inundation of the Seal Creek Marsh. Although Seal Creek Marsh is readily identified as a marsh in the aerial photographs, the degree of site inundation varies significantly, probably with rainfall patterns. For example, marsh flooding is not apparent in photographs taken before August 6, 1996, but Seal Creek Marsh is inundated in the August 6, 1996, photographs ([PRC 1996](#)).

The dates of debris disposal and the source of the debris at the site are unknown. The debris includes blue-colored glass bottles and ceramic fragments, suggesting that the waste is perhaps 40 to 65 years old or older.

##### **1.1.4.2 Site 01 – Tidal Area Landfill**

The Tidal Area Landfill is located along the western side of Johnson Road, just north of Froid Road ([Figure 3](#)). The landfill covers approximately 13 acres and contains an estimated 33,000 tons of waste ([International Technology Corporation \[IT\] 1992](#)). The landfill served as the major disposal area for NWSSB Detachment Concord from approximately 1944 to 1979. As shown by the growth of the landfill perimeter in historical aerial photographs, most of the waste was deposited in the landfill from 1959 to 1974. Household garbage from the NWSSB Detachment Concord and surrounding communities was disposed of at the landfill. In addition, the landfill reportedly received solvents, acids, paint cans, creosote-treated timbers, asphalt, concrete, asbestos, and ordnance materials including inert munitions ([Ecology and Environment \[E&E\] 1983](#)). Shipboard wastes and the tritonal filler from one, 750-pound, general-purpose bomb were reportedly buried in the landfill (E&E 1983); however, the Navy considers it possible but highly unlikely that tritonal filler was disposed of in the landfill ([Heller 1998](#)).

## Figures 2 and 3

These detailed station maps have been deleted from the Internet-accessible version of this document as per Department of the Navy Internet security regulations.



Historical photographs indicate that the Tidal Area Landfill was created by the progressive disposal of soil and debris outward from Johnson Road. The soil and debris were placed on native soil. A waste thickness of up to 10 feet was estimated from topographic evaluation; however, the waste may be unevenly distributed, and the ratio of waste to soil cover in the fill may be variable (IT 1992). The origin of the soil cover is unknown. Geotechnical evaluation of the site for the FS indicated that the landfill is situated on highly compressible Bay Mud that is susceptible to significant future settlement as a result of new loads. There is no record of the degree of historic subsidence of the landfill. Presently, a fence borders the edge of the landfill along Johnson Road.

### **1.1.5 Physical Setting**

The following paragraphs provide a brief description of the physical setting for Site 30 and Site 01.

#### **1.1.5.1 Site 30 – Taylor Boulevard Bridge Disposal Area**

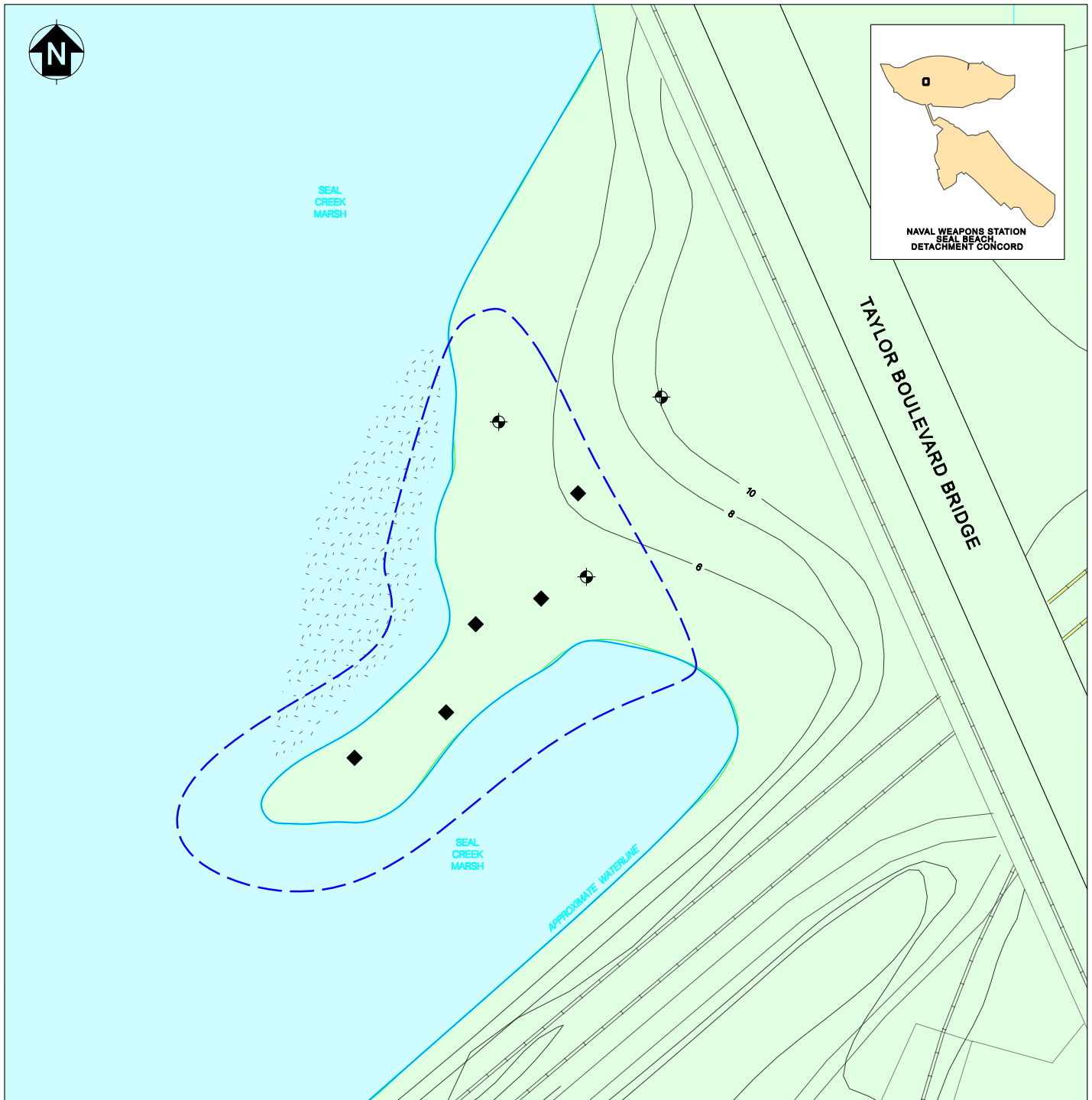
The TBB Disposal Area is a small wetland adjacent to the Seal Creek Marsh. Vegetation includes wetland and wetland/upland species. It has no paved areas, no buildings are present, and no physical evidence exists of any previous construction at the site. The nearest improvements are the Taylor Boulevard Bridge and the Taylor Boulevard Railroad Bridge, which span the eastern side of the site. The elevation at the center of the site is 6 feet higher than the surrounding marsh. No portion of the site is higher than 12 feet above mean sea level. The Santa Fe Railroad tracks are immediately south of the site, and Waterfront Road and the Southern Pacific Railroad tracks are immediately north of the site (see [Figure 2](#)).

Debris consisting of broken glass, burned metal, and partially burned wooden railroad ties litter the ground surface at much of the site. Glass and metal debris cover a triangular area extending about 180 by 180 feet and extend into the open water and onto a peninsula (see [Figure 4](#)). Surface vegetation covers the debris in most areas.

#### **1.1.5.2 Site 01 – Tidal Area Landfill**

The horizontal extent of the Site 01 landfill has been established based on historical aerial photographs and visual site inspection. The landfill boundary on the east side is determined by a road; and on the south, north, and west sides, the boundary is visually apparent as well as defined by a sudden change in slope from the flat wetland into the raised mound of the landfill material. The landfill surface at Site 01 was delineated as an upland area ([Western Ecological Services Company, Inc. 1995](#)) with a salt marsh-designated wetland area along the western and southern boundaries of the landfill.

The landfill consists predominantly of ruderal, nonnative grassland habitat. The surface of the landfill comprises a discontinuous soil cover mixed with waste throughout the depth of the landfill. Currently, rubble, metal scraps, and wood debris are visible through the soil layer. Animal burrows and differential subsidence have resulted in a highly uneven surface interrupted by deep potholes.



30 0 30 60  
Feet

- ◆ Proposed Debris Bore & Sediment Sample
- ⊕ Proposed Groundwater Monitoring Well
- Topographic Elevation Contour (feet, NDVD 1929)
- Scattered Debris Surface
- Primary Debris Area

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**FIGURE 4**  
**PROPOSED DEBRIS BORE AND**  
**GROUNDWATER MONITORING WELL**  
**LOCATIONS**

SAP FOR ADDITIONAL REMEDIAL INVESTIGATION  
FOR THE TAYLOR BOULEVARD BRIDGE (SITE 30)  
AND TIDAL AREA LANDFILL (SITE 01)

### **1.1.6 Previous Investigations**

The following paragraphs provide a brief description of previous investigations conducted for Site 30 and Site 01.

#### **1.1.6.1 Site 30 – Taylor Boulevard Bridge Disposal Area**

To date, the Site 30 RI has consisted of a series of five soil and sediment sampling events beginning in February 1996. These investigations have served to characterize the soil and sediment chemistry and determine the nature and extent of chemicals likely to originate from on-site debris. Additional sampling to address the ecological risk assessment (ERA) data needs was conducted during February and March 2000 ([Tetra Tech 2002](#)). The ERA-focused sampling included collection of composite sediment samples for metals analysis and bioassays and collection of pickleweed and amphipods for tissue residue analysis. Twenty-two test pits were also dug throughout the site during the ERA-focused sampling in an effort to determine the depth and lateral extent of the debris. Debris was detected in 13 of the 22 test pits.

Sediment samples collected below 1 foot below ground surface (bgs) did not contain significant concentrations of chemicals, suggesting that chemicals detected in surface sediments have not migrated vertically by leaching ([Tetra Tech 2002](#)). With respect to surface water, the California Regional Water Quality Control Board (RWQCB) collected seven surface water samples in the Seal Creek Marsh directly offshore from the Site 30 in December 2001. The RWQCB samples were analyzed for total and dissolved metals. Chromium (a total metal) was detected at one location, and zinc (a dissolved metal) was detected at several locations. Concentrations for both total and dissolved metals were, however, well below the ambient water quality control values calculated based on a hardness of 400 milligrams per liter (mg/L). Hardness values in samples collected ranged from 2,600 mg/L to 2,800 mg/L; however, 400 mg/L is the upper value allowed by the California Toxics Rule).

#### **1.1.6.2 Site 01 – Tidal Area Landfill**

During the RI, surface and subsurface soil sampling was conducted around the perimeter of the landfill to assess whether chemicals may be migrating from the landfill. Eight locations were sampled, and 24 samples were analyzed; only one organic compound was detected in soil at a concentration greater than the EPA Region 9 residential preliminary remediation goal (PRG) ([EPA 2000e](#)). The polycyclic aromatic hydrocarbon benzo(a)pyrene was detected in a surface soil sample from the western edge of the landfill. Three metals (arsenic, beryllium, and lead) were detected at concentrations greater than their residential PRGs and estimated ambient metal concentrations; arsenic and beryllium were detected in surface and subsurface soil samples, and lead was detected in surface soil samples. Landfill contents were not characterized during the RI.

### **1.1.7 Principal Decision-Makers**

Principal decision-makers include the Navy, regulatory agencies (EPA Region 9, the California Environmental Protection Agency Department of Toxic Substances Control, and RWQCB), and the public. These decision-makers will use the data collected from this project in conjunction with data generated during previous investigations to evaluate whether additional work is required at the TBB Disposal Area or Tidal Area Landfill.

### **1.1.8 Technical or Regulatory Standards**

To assess human health risk, metal concentrations in groundwater samples will be compared with EPA Region 9 PRGs for tap water ([EPA 2002a](#)) and EPA maximum contaminant levels ([EPA 2002b](#)). These metal concentrations will also be compared with EPA's national recommended water quality criteria ([EPA 2002c](#)), EPA's State of California water quality criteria (California Toxics Rule), and the Bay Basin plan objectives upstream of San Pablo Bay ([RWQCB 1995](#)) to assess ecological risk.

## **1.2 PROJECT DESCRIPTION**

The following sections discuss the objectives and measurements of the project. [Table 2](#) presents a schedule of sampling, analysis, and reporting for this project.

### **1.2.1 Project Objectives**

As stated in [Section 1.1](#), the primary objectives of the additional RI at Site 30 are to (1) characterize groundwater quality, (2) determine the vertical extent of the debris, and (3) determine metal concentrations in sediment beneath the debris. These additional data will supplement the information already compiled in the draft final RI report ([Tetra Tech 2002b](#)). The primary purpose of the additional RI at Site 01 is address whether leachate from the landfill has migrated to groundwater since groundwater was last sampled in 1998 ([Tetra Tech 1998a](#)).

### **1.2.2 Project Measurements**

To meet the project objectives, the following measurements will be conducted:

- Site 30 – Three monitoring wells will be installed and sampled to assess groundwater quality. Two rounds of samples will be collected. Samples will be filtered and analyzed for dissolved metals and pH.
- Site 30 – Five discrete cores will be collected to delineate the vertical extent of the debris. Sediment samples will be collected and analyzed from the bottom of each debris core. Sediment samples will be analyzed for metals, pH, and TOC.

## TABLE 2: IMPLEMENTATION SCHEDULE FOR SAMPLING, ANALYSIS, AND REPORTING

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

Milestone	Due Date	Anticipated Date
Internal draft SAP	December 10, 2002	December 10, 2002
Navy review of SAP	10 calendar days after internal draft SAP is submitted for review	December 20, 2002
Draft SAP to regulatory agencies	9 calendar days after Navy comments are received	December 29, 2002
Regulatory agency review of SAP	60 calendar days after draft SAP submitted for agency review	February 28, 2003
Internal draft final SAP	30 calendar days after all regulatory agency comments are received	March 27, 2003
Navy review of SAP	14 calendar days after internal draft SAP is submitted for review	April 13, 2003
Draft final SAP to regulatory agencies	15 calendar days after Navy comments are received	April 28, 2002
TBB Disposal Area and TA Landfill field investigation	30 calendar days after draft final SAP submitted to regulatory agencies	May 25, 2003
Internal draft final letter report for Site 01	45 calendar days after TBB Disposal Area and TA Landfill field investigation	July 15, 2003
Navy review of internal final letter report for Site 01	14 calendar days after internal draft final letter report submitted for Navy review	July 25, 2003
Draft final letter report for Site 01	30 calendar days after Navy comments are received	August 25, 2003
Agency review of Site 01 letter report	30 calendar days after internal draft final letter report submitted for agency review	September 24, 2003
Internal draft final letter report for Site 30	30 calendar days after draft final letter report for Site 01	September 25, 2003
RTC on draft final Site 01 letter report	30 calendar days after all regulatory agency comments are received	October 24, 2003
Navy review of internal final letter report for Site 30	14 calendar days after internal draft final letter report submitted for Navy review	October 9, 2003
Draft final letter report for Site 30	30 calendar days after Navy comments are received	November 9, 2003
Agency review of Site 30 letter report	30 calendar days after internal draft final letter report submitted for agency review	December 9, 2003
RTC on draft final Site 30 letter report	30 calendar days after all regulatory agency comments are received	January 8, 2004

### Notes:

HASP	Health and safety plan	TA	Tidal Area
RTC	Response to comments	TBB	Taylor Boulevard Bridge
SAP	Sampling and analysis plan		

- Site 01 – One groundwater sample will be collected from each of the seven existing wells at the Tidal Area landfill. Groundwater samples will be analyzed for VOCs, SVOCs, metals, and TPH.

Investigation-derived waste (IDW) will be produced during the sampling activities. Sediment IDW will be sampled and analyzed for waste extraction test (WET) metals and pH. Groundwater from developing and purging new monitoring wells and water from decontamination will be containerized in 55-gallon drums and will also be sampled and analyzed for VOCs, SVOCs, metals, TPH, and pH. All samples will be analyzed at an off-site laboratory.

### **1.3 QUALITY OBJECTIVES AND CRITERIA**

The following sections present the data quality objectives (DQO) and measurement quality objectives (MQO) identified for this project.

#### **1.3.1 Data Quality Objectives**

DQOs are qualitative and quantitative statements developed through the seven-step DQO process ([EPA 2000b, 2000d](#)). The DQOs clarify the study objective, define the most appropriate data to collect and the conditions under which to collect the data, and specify tolerable limits on decision errors that will be used as the basis for establishing the quantity and quality of data needed to support decision-making. The DQOs are used to develop a scientific and resource-effective design for data collection. The seven steps of the DQO process for this project are presented in [Table 3](#).

#### **1.3.2 Measurement Quality Objectives**

All analytical results will be evaluated in accordance with precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters to document the quality of the data and to ensure that the data are of sufficient quality to meet the project objectives. Of these PARCC parameters, precision and accuracy will be evaluated quantitatively by collecting the quality control (QC) samples listed in [Table 4](#). Specific precision and accuracy goals for these QC samples are listed in [Appendix A](#).

The following sections describe each of the PARCC parameters and how they will be assessed within this project.

##### **1.3.2.1 Precision**

Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. Combined field and laboratory precision is usually evaluated by collecting and analyzing field duplicates and then calculating the variance between the samples, typically as a relative percent difference (RPD).

### TABLE 3: DATA QUALITY OBJECTIVES

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

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#### STEP 1: State the Problem

---

- Chemical concentrations in groundwater at Site 30 have not been characterized.
  - The vertical extent of the debris at Site 30 has not been fully characterized in areas where debris extends deeper than 3 feet below ground surface.
  - Chemical concentrations in sediment have not been fully characterized in areas where the debris extends deeper than 3 feet below ground surface.
  - The EPA has requested another round of groundwater sampling to confirm that leachate from the Site 01 landfill is not migrating to groundwater since groundwater was last sampled in 1998. Additionally, these data will also be used to provide information regarding the number and array of new wells needed for the Site 01 groundwater study, which is planned for mid 2003.
- 

#### STEP 2: Identify the Decisions

---

- Are metals present at concentrations above chronic ambient water quality criteria in groundwater samples at Site 30?
  - Does debris at Site 30 extend deeper than 3 feet below ground surface?
  - Are metal concentrations in sediment beneath the debris at Site 30 above tidal area ambient and effects range concentrations?
  - Are target constituents (metals, VOCs, SVOCs, and TPH) present at concentrations above chronic ambient water quality criteria in groundwater samples at Site 01?
- 

#### STEP 3: Identify Inputs to the Decisions

---

- Analytical results for groundwater samples collected from three monitoring wells at Site 30. Samples will be analyzed for metals, TOC, and pH.
  - Five discrete cores to delineate the vertical extent of the debris at Site 30.
  - Analytical results for sediment samples collected from the bottom of each debris core at Site 30.
  - Analytical results for groundwater samples collected from seven monitoring wells at Site 01. Samples will be analyzed for metals, VOCs, SVOCs, and TPH.
- 

#### STEP 4: Define Study Boundaries

---

- The spatial boundary will be limited to the boundaries for Sites 30 and 01. Site 30, is a triangular shaped area of less than 1 acre located beneath the Taylor Boulevard Bridge. Site 30 is bordered by wetlands to the south and west and is adjacent to Seal Creek Marsh. For Site 01, the landfill boundary on the east side is determined by a road; and on the south, north, and west sides, the boundary is defined by a sudden change in slope from the flat wetland into the raised mound of the landfill material.
  - Temporal boundaries extend through the period of performance of the task order.
- 

#### STEP 5: Develop Decision Rules

---

- If metals in groundwater collected from Site 30 are detected at concentrations above the chronic AWQC, then these compounds will be designated groundwater COPCs and further evaluated in the FS. Otherwise, groundwater will not be further evaluated at this site.
  - If debris at Site 30 extends deeper than three feet, an addendum to the Site 30 final RI will be provided and the new information used in the FS to assist with risk management decisions.
  - If metals in sediment collected from Site 30 are detected at concentrations above the ER-M then these chemicals will be further evaluated in the FS. Otherwise, sediment will not be further evaluated.
  - If landfill leachate has migrated to groundwater since 1998, this new information will be incorporated into the design of the upcoming groundwater study for the Site 01.
-

### TABLE 3: DATA QUALITY OBJECTIVES (Continued)

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

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#### STEP 6: Specify Tolerable Limits on Decision Errors

---

- Site-specific sampling objectives and the media being investigated will limit the use of statistical methods in selecting sampling locations for this RI. Sampling locations will be based on prior knowledge of likely waste disposal. Tolerable limits on decision errors cannot be precisely defined.
- 

#### STEP 7: Optimize the Sampling Design

---

- The three locations selected for installation of groundwater at Site 30 are judgmentally placed to evaluate whether debris from the site is contributing to groundwater contamination. One well will be installed up gradient of the debris, and another two will be installed within the debris field. Because the debris is on the shoreline adjacent to open water, installation of a well downgradient from the site is not feasible.
  - The five debris core locations at Site 30 were based on a review of test pits previously dug at the site, for which the bottom of the debris was not fully characterized.
  - At Site 01, seven existing monitoring wells will be sampled.
- 

#### Notes:

AWQC	Ambient water quality criteria
COPC	Contaminants of potential concern
EPA	U.S. Environmental Protection Agency
ER-M	Effects range-medium
FS	Feasibility study
RI	Remedial investigation
SVOC	Semivolatile organic compound
TOC	Total organic carbon
TPH	Total petroleum hydrocarbon
VOC	Volatile organic compound



**TABLE 4: QUALITY CONTROL SAMPLES FOR PRECISION AND ACCURACY**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and  
the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

QC Type	Precision	Accuracy	Frequency
Field QC	Field Duplicate	None	Field Duplicate = 10 percent of samples (groundwater)
		Equipment Rinsate	Equipment Rinsate = 1/day/piece of equipment used for sampling
		Source Water Blank	Source Water Blank = 1/sampling event/source of water used for the final decontamination rinse
		Trip Blank	Trip Blank = 1/transport container with samples for volatile analyses
Laboratory QC	MS/MSD RPD	MS/MSD %R	MS/MSD = 1/20 samples (soil), 1/20 samples (groundwater)
		Method Blanks	Method Blank = 1/20 samples
		LCS or Blank Spikes	LCS or Blank Spikes = 1/20 samples
		Surrogate Standards %R	Surrogate Standards = Every sample for organic analysis by GC
		Internal Standards %R	Internal Standards = Every sample for organic analysis by GC

Notes:

%R	Percent recovery
GC	Gas chromatography
LCS	Laboratory control sample
MS/MSD	Matrix spike/matrix spike duplicate
QC	Quality control
RPD	Relative percent difference

$$RPD = \frac{|A - B|}{(A + B)/2} \times 100\%$$

where:

- A = First duplicate concentration
- B = Second duplicate concentration

Field sampling precision is evaluated by analyzing field duplicate samples. Because it is not practical to obtain true field duplicate sediment samples, field duplicates will only be collected for groundwater for this project.

Laboratory analytical precision is evaluated by analyzing laboratory duplicates or matrix spikes (MS) and matrix spike duplicates (MSD). For this project, MS/MSD samples will be generated for all analytes. The results of the analysis of each MS/MSD pair will be used to calculate an RPD for evaluating precision.

### **1.3.2.2 Accuracy**

A program of sample spiking will be conducted to evaluate laboratory accuracy. This program includes analysis of the MS and MSD samples, laboratory control samples (LCS) or blank spikes, surrogate standards, and method blanks. MS and MSD samples will be prepared and analyzed at a frequency of 5 percent for soil samples. LCS or blank spikes are also analyzed at a frequency of 5 percent. Surrogate standards, where available, are added to every sample analyzed for organic constituents. The results of the spiked samples are used to calculate the percent recovery for evaluating accuracy.

$$\text{Percent Recovery} = \frac{S - C}{T} \times 100$$

where:

- S = Measured spike sample concentration
- C = Sample concentration
- T = True or actual concentration of the spike

[Appendix A](#) presents accuracy goals for the RI based on the percent recovery of matrix and surrogate spikes. Results that fall outside the accuracy goals will be further evaluated on the basis on the results of other QC samples.

### **1.3.2.3 Representativeness**

Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that they are intended to represent. For this project, representative data will be obtained through careful selection of sampling locations and analytical parameters.

Representative data will also be obtained through proper collection and handling of samples to avoid interference and minimize contamination.

Representativeness of data will also be ensured through the consistent application of established field and laboratory procedures. Field blanks (if appropriate) and laboratory blank samples will be evaluated for the presence of contaminants to aid in evaluating the representativeness of sample results. Data determined to be nonrepresentative, by comparison with existing data, will be used only if accompanied by appropriate qualifiers and limits of uncertainty.

#### **1.3.2.4      *Completeness***

Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with QC procedures outlined in this SAP, and when none of the QC criteria that affect data usability are exceeded. When all data validation is completed, the percent completeness value will be calculated by dividing the number of useable sample results by the total number of sample results planned for this RI.

As discussed further in [Section 4.2](#), completeness will also be evaluated as part of the data quality assessment process (EPA 2000c). This evaluation will help determine whether any limitations are associated with the decisions to be made based on the data collected.

#### **1.3.2.5      *Comparability***

Comparability expresses the confidence with which one data set can be compared with another. Comparability of data will be achieved by consistently following standard field and laboratory procedures and by using standard measurement units in reporting analytical data.

#### **1.3.2.6      *Detection and Quantitation Limits***

The method detection limit (MDL) is the minimum concentration of an analyte that can be reliably distinguished from background noise for a specific analytical method. The quantitation limit represents the lowest concentration of an analyte that can be accurately and reproducibly quantified in a sample matrix. Project-required reporting limits (PRRL) are contractually specified maximum quantitation limits for specific analytical methods and sample matrices, such as sediment or water, and are typically several times the MDL to allow for matrix effects. PRRLs, which are established by Tetra Tech in the scope of work for subcontract laboratories, are set to establish minimum criteria for laboratory performance; actual laboratory quantitation limits may be substantially lower.

For this project, analytical methods have been selected so that the PRRL for each target analyte is below the applicable regulatory screening criteria, chronic AWQCs for groundwater, and tidal area ambient concentrations for sediment, wherever practical. [Appendix D](#) compares the PRRLs for the selected analytical methods with both freshwater and marine AWQCs; the most conservative of the

two will be used to screen groundwater results. This comparison shows that the selected analytical methods and associated PRRLs are capable of quantifying contaminants of concern at concentrations below the chronic AWQC in nearly all cases. The specific exceptions include the target compounds 3,3-dichlorobenzidine, benzo(a)pyrene, bis(2-chloethyl)ether, dibenzo(a,h,)anthracene, hexachlorobenzene, n-nitroso-di-n-propylamine, and arsenic. These few exceptions have been judged to be acceptable for the following reasons:

- AWCQs are to be used for initial screening of analytical results; they will not be used for compliance.
- All of the exceptions involve target analytes that are not specifically suspected of being present at this site but which are being included to assure a broad screening for chemicals of potential concern (COPC).
- Most of the exceptions involve target analytes associated with multiple component analyses, where the broad applicability of the selected method is more important than ensuring that each target analyte has a PRRL below the chronic AWQC.
- Actual laboratory quantitation limits may be lower than PRRLs, and analyte concentrations down to MDLs can typically be estimated to allow comparisons to screening levels below PRRLs.

For this project, samples analyzed for SVOCs, VOCs, and metals will be reported as estimated values if concentrations are less than PRRLs but greater than MDLs. The MDL for each analyte will be listed as the detection limit in the laboratory's electronic data deliverable (EDD). This procedure is being adopted to help ensure that analytical results can effectively be compared with screening values for certain compounds where the PRRL is near or below the screening value. This procedure also will help to ensure that subsequent statistical evaluations of the data will not be biased by high-value nondetect results.

## **1.4 PROJECT ORGANIZATION**

[Table 5](#) presents the responsibilities and contact information for key personnel involved in field investigation activities at Sites 30 and 01 at NWSSB Detachment Concord. In some cases, more than one responsibility has been assigned to one person. [Figure 5](#) presents the organization of the project team.

**TABLE 5: KEY PERSONNEL**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01),  
Naval Weapons Station Seal Beach Detachment, Concord

Name	Organization	Role	Responsibilities	Contact Information
Gil Rivera	Navy	Remedial project manager	Responsible for overall project execution and for coordination with base representatives, regulatory agencies, and Navy management Actively participates in DQO process Provides management and technical oversight during data collection	Naval Facilities Engineering Command, Southwest Division (SWDIV), Daly City, CA <a href="mailto:RiveraGA@efawest.navfac.navy.mil">RiveraGA@efawest.navfac.navy.mil</a> (650) 746-7451
Narciso A. Ancog	Navy	QA officer	Responsible for QA issues for all SWDIV environmental work Provides government oversight of Tetra Tech's QA program Reviews and approves SAP and any significant modifications Has authority to suspend project activities if Navy quality requirements are not met	Naval Facilities Engineering Command, SWDIV, San Diego, CA <a href="mailto:ancogna@efdswnavfac.navy.mil">ancogna@efdswnavfac.navy.mil</a> (619) 532-2540
Joanna Canepa	Tetra Tech	Installation coordinator	Responsible for ensuring that all Tetra Tech activities at this installation are carried out in accordance with current Navy requirements and Tetra Tech AECRU program guidance	Tetra Tech, San Francisco, CA <a href="mailto:John.Bosche@TtEMI.com">John.Bosche@TtEMI.com</a> (415) 222-8295
Rik Lantz	Tetra Tech	Hydrogeologist	Responsible for implementing all activities called out in DO Prepares or supervises preparation of SAP Monitors and directs field activities to ensure compliance with SAP requirements	Tetra Tech, Chicago, IL <a href="mailto:Rik.Lantz@TtEMI.com">Rik.Lantz@TtEMI.com</a> (312) 946-6435
Greg Swanson	Tetra Tech	Program QA manager	Responsible for regular discussion and resolution of QA issues with Navy QA officer Provides program-level QA guidance to installation coordinator, project manager, and project teams Reviews and approves SAPs Identifies nonconformances through audits and other QA review activities and recommends corrective action	Tetra Tech, San Diego, CA <a href="mailto:Greg.Swanson@TtEMI.com">Greg.Swanson@TtEMI.com</a> (619) 525-7188

**TABLE 5: KEY PERSONNEL (Continued)**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01),  
Naval Weapons Station Seal Beach Detachment, Concord

Name	Organization	Role	Responsibilities	Contact Information
Ron Ohta	Tetra Tech	Project QA officer	Responsible for providing guidance to project teams that are preparing SAPs Verifies that data collection methods specified in SAP comply with Navy and Tetra Tech requirements May conduct laboratory evaluations and audits	Tetra Tech, Sacramento, CA <a href="mailto:Ron.Ohta@TtEMI.com">Ron.Ohta@TtEMI.com</a> (916) 853-4506
To be determined	Tetra Tech	Field team leader	Responsible for directing day-to-day field activities conducted by Tetra Tech and subcontractor personnel Verifies that field sampling and measurement procedures follow SAP Provides project manager with regular reports on status of field activities	To be determined
To be determined	Tetra Tech	On-site safety officer	Responsible for implementing health and safety plan and for determining appropriate site control measures and personal protection levels Conducts safety briefings for Tetra Tech and subcontractor personnel and site visitors Can suspend operations that threaten health and safety	To be determined
Kevin Hoch	Tetra Tech	Chemist	Responsible for working with project team to define analytical requirements Assists in selecting a pre-qualified laboratory to complete required analyses (see <a href="#">Section 2.4</a> of SAP) Coordinates with laboratory project manager on analytical requirements, delivery schedules, and logistics Reviews laboratory data before they are released to project team	Tetra Tech, San Francisco, CA <a href="mailto:Kevin.Hoch@TtEMI.com">Kevin.Hoch@TtEMI.com</a> (415) 222-8304
Wing Tse	Tetra Tech	Database manager	Responsible for developing, monitoring, and maintaining project database under guidance of project manager Works with analytical coordinator during preparation of SAP to resolve sample identification issues	Tetra Tech, San Francisco, CA <a href="mailto:Wing.Tse@TtEMI.com">Wing.Tse@TtEMI.com</a> (415) 222-8326

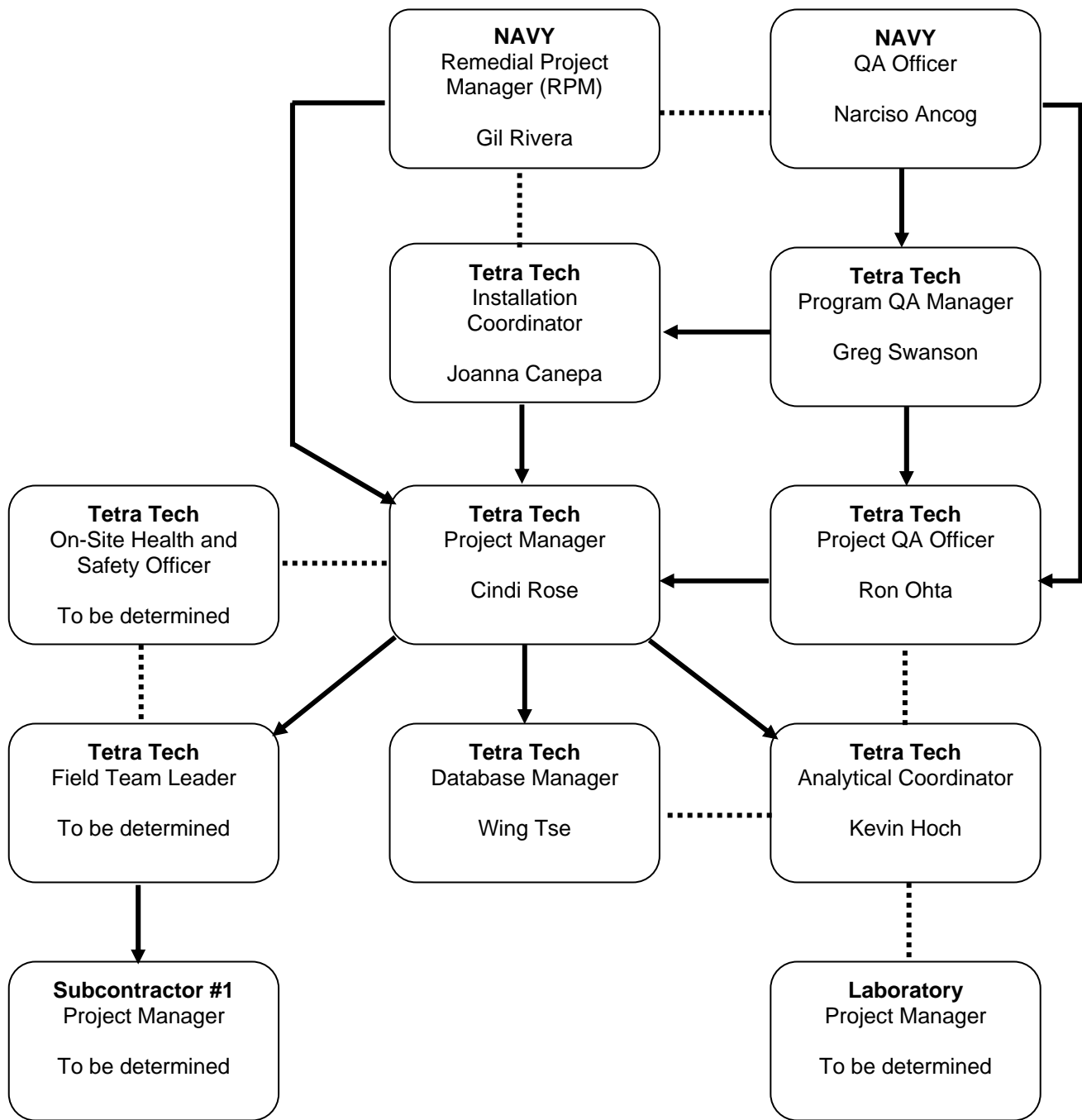
**TABLE 5: KEY PERSONNEL (Continued)**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01),  
Naval Weapons Station Seal Beach Detachment, Concord

Name	Organization	Role	Responsibilities	Contact Information
To be determined	Laboratory	Project manager	Responsible for delivering analytical services that meet requirements of SAP Reviews SAP to understand analytical requirements Works with Tetra Tech analytical coordinator to confirm sample delivery schedules Reviews laboratory data package before it is delivered to Tetra Tech	To be determined
To be determined	Subcontractor	Project manager	Responsible for ensuring that subcontractor activities are conducted in accordance with requirements of SAP Coordinates subcontractor activities with Tetra Tech project manager or field team leader	To be determined

Notes:

AECRU	Indefinite Quantity Contract for Architectural-Engineering Services to Provide CERCLA/RCRA/UST Studies
DQO	Data quality objective
Navy	U.S. Department of the Navy
QA	Quality assurance
RPM	Remedial project manager
SAP	Sampling and analysis plan
SWDIV	Naval Facilities Engineering Command, Southwest Division
Tetra Tech	Tetra Tech EM Inc.



Lines of Authority —————  
 Lines of Communication .....



**Naval Station Seal Beach Detachment**  
 U.S. Navy Southwest Division, NAVFAC, Daly City

**FIGURE 5**  
**PROJECT TEAM ORGANIZATION CHART**

Additional Remedial Investigation for the Taylor Boulevard Bridge  
 (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons  
 Station Seal Beach Detachment, Concord



## **1.5 SPECIAL TRAINING AND CERTIFICATION**

This section outlines the training and certification required to complete the activities described in this SAP. The following sections describe the requirements for Tetra Tech and subcontractor personnel working on site.

### **1.5.1 Health and Safety Training**

Tetra Tech personnel who work at hazardous waste project sites are required to meet the Occupational Safety and Health Administration (OSHA) training requirements defined in Title 29 *Code of Federal Regulations* (CFR) Part 1910.120(e). These requirements include (1) 40 hours of formal off-site instruction, (2) a minimum of 3 days of actual on-site field experience under the supervision of a trained and experienced field supervisor, and (3) 8 hours of annual refresher training. Field personnel who directly supervise employees engaged in hazardous waste operations also receive at least 8 additional hours of specialized supervisor training. The supervisor training covers AECRU health and safety program requirements, training requirements, personal protective equipment (PPE) requirements, spill containment program, and health-hazard monitoring procedures and techniques. At least one member of every Tetra Tech field team will maintain current certification in the American Red Cross “Multimedia First Aid” and “Cardiopulmonary Resuscitation (CPR) Modular” or equivalent.

Copies of Tetra Tech’s health and safety training records, including course completion certifications for the initial and refresher health and safety training, specialized supervisor training, and first aid and CPR training, are maintained in project files.

Before work begins at a specific hazardous waste project site, Tetra Tech personnel are required to undergo site-specific training that thoroughly covers the following areas:

- Names of personnel and alternates responsible for health and safety at a hazardous waste project site
- Health and safety hazards present on site
- Selection of the appropriate personal protection levels
- Correct use of PPE
- Work practices to minimize risks from hazards
- Safe use of engineering controls and equipment on site
- Medical surveillance requirements, including recognition of symptoms and signs that might indicate overexposure to hazardous substances
- Contents of the base-wide health and safety plan (HASP) ([Tetra Tech 1998b](#))

### **1.5.2 Subcontractor Training**

Subcontractors who work on site will certify that their employees have been trained for work on hazardous waste project sites. Training will meet OSHA requirements defined in Title 29 CFR Part 1910.120(e). Before work begins at the project site, subcontractors will submit copies of the training certification for each employee to Tetra Tech.

All employees of associate and professional services firms and technical services subcontractors will attend a safety briefing and complete the “Safety Meeting Sign-Off Sheet” before they conduct on-site work. This briefing covers the topics described in [Section 1.5.1](#) and is conducted by the Tetra Tech on-site health and safety officer or other qualified person.

Subcontractors are responsible for conducting their own safety briefings. Tetra Tech personnel may audit these briefings.

### **1.5.3 Specialized Training and Certification Requirements**

To achieve analytical detection limits for mercury that are lower than the applicable regulatory criterion, specialized “ultra-clean” sampling methods will be required. Prior to collecting groundwater samples, samplers will be trained on using Method 1669 ([Appendix F](#)), the “clean hands” method. No specialized certifications are required for this sampling investigation.

## **1.6 DOCUMENTS AND RECORDS**

Documentation is critical for evaluating the success of any environmental data collection activity. The following sections discuss the requirements for documenting field activities and for preparing laboratory data packages. This section also describes reports that will be generated as a result of this project.

### **1.6.1 Field Documentation**

Complete and accurate documentation is essential to demonstrate that field measurement and sampling procedures are carried out as described in the SAP. Field personnel will use permanently bound field logbooks with sequentially numbered pages to record and document field activities. The logbook will list the contract name and number, the DO number, the site name, and the names of subcontractors, the service client, and the project manager. At a minimum, the following information will be recorded in the field logbook:

- Name and affiliation of all on-site personnel or visitors
- Weather conditions during the field activity
- Summary of daily activities and significant events

- Notes of conversations with coordinating officials
- References to other field logbooks or forms that contain specific information
- Discussions of problems encountered and their resolution
- Discussions of deviations from the SAP or other governing documents
- Description of all photographs taken

The field team will also use the various field forms included in [Appendix C](#) to record field activities.

### **1.6.2 Summary Data Package**

The subcontracted laboratory will prepare summary data packages in accordance with the instructions provided in the EPA Contract Laboratory Program (CLP) statements of work (SOW) ([EPA 1999a, 2000a](#)). The summary data package will consist of a case narrative, copies of all associated chain-of-custody forms, sample results, and quality assurance (QA) and QC summaries. The case narrative will include the following information:

- Subcontractor name, project name, DO number, project order number, sample delivery group (SDG) number, and a table that cross-references client and laboratory sample identification (ID) numbers
- Detailed documentation of all sample shipping and receiving, preparation, analytical, and quality deficiencies
- Thorough explanation of all instances of manual integration
- Copies of all associated nonconformance and corrective action forms that will describe the nature of the deficiency and the corrective action taken
- Copies of all associated sample receipt notices

Additional requirements for the summary data package are outlined in [Table 6](#). The subcontracting laboratory will provide Tetra Tech with two copies of the summary data package within 28 days after it receives the last sample in the SDG.

### **1.6.3 Full Data Package**

When a full data package is required, the laboratory will prepare data packages in accordance with the instructions provided in the EPA CLP SOWs ([EPA 1999a, 2000a](#)). Full data packages will contain all of the information from the summary data package and all associated raw data. Full data package requirements are outlined in [Table 6](#). Full data packages are due to Tetra Tech within 35 days after the last sample in the SDG is received. Unless otherwise requested, the subcontractor will deliver one copy of the full data package.

**TABLE 6: REQUIREMENTS FOR SUMMARY AND FULL DATA PACKAGES**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01),  
Naval Weapons Station Seal Beach Detachment, Concord

Requirements for Summary Data Packages – Organic Analysis		Requirements for Summary Data Packages – Inorganic Analysis	
<u>Section I</u>	Case Narrative	<u>Section I</u>	Case Narrative
1.	Case narrative	1.	Case narrative
2.	Copies of nonconformance and corrective action forms	2.	Copies of nonconformance and corrective action forms
3.	Chain-of-custody forms	3.	Chain-of-custody forms
4.	Copies of sample receipt notices	4.	Copies of sample receipt notices
5.	Internal tracking documents, as applicable	5.	Internal tracking documents, as applicable
<u>Section II</u>	Sample Results - Form I for the following:	<u>Section II</u>	Sample Results - Form I for the following:
1.	Environmental samples, including dilutions and re-analysis	1.	Environmental sample including dilutions and re-analysis
2.	Tentatively identified compounds (TIC) (VOC and SVOC only)		
<u>Section III</u>	QA/QC Summaries - Forms II through XI for the following:	<u>Section III</u>	QA/QC Summaries - Forms II through XIV for the following:
1.	System monitoring compound and surrogate recoveries (Form II)	1.	Initial and continuing calibration verifications (Form II)
2.	MS and MSD recoveries and RPDs (Forms I and III)	2.	PRRL standard (Form II)
3.	Blank spike or LCS recoveries (Forms I and III-Z)	3.	Detection limit standard (Form II-Z)
4.	Method blanks (Forms I and IV)	4.	Method blanks, continuing calibration blanks, and preparation blanks (Form III)
5.	Performance check (Form V)	5.	Inductively coupled plasma (ICP) interference-check samples (Form IV)
6.	Initial calibrations with retention time information (Form VI)	6.	MS and post-digestion spikes (Forms V and V-Z)
7.	Continuing calibrations with retention time information (Form VII)	7.	Sample duplicates (Form VI)
8.	Quantitation limit standard (Form VII-Z)	8.	LCSs (Form VII)
9.	Internal standard areas and retention times (Form VIII)	9.	Method of standard additions (Form VIII)
10.	Analytical sequence (Forms VIII-D and VIII-Z)	10.	ICP serial dilution (Form IX)
11.	Gel permeation chromatography (GPC) calibration (Form IX)	11.	IDL (Form X)
12.	Single component analyte identification (Form X)	12.	ICP interelement correction factors (Form XI)
13.	Multicomponent analyte identification (Form X-Z)	13.	ICP linear working range (Form XII)
14.	Matrix-specific method detection limit (MDL) (Form XI-Z)		

**TABLE 6: REQUIREMENTS FOR SUMMARY AND FULL DATA PACKAGES (Continued)**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01),  
Naval Weapons Station Seal Beach Detachment, Concord

Requirements for Full Data Packages -- Organic Analysis		Requirements for Full Data Packages -- Inorganic Analysis	
<u>Sections I, II, and III</u> Summary Package		<u>Sections I, II, III</u> Summary Package	
<b><u>Section IV</u> Sample Raw Data - indicated form, plus all raw data</b>		<b><u>Section IV</u> Instrument Raw Data - Sequential measurement readout records for ICP, graphite furnace atomic absorption (GFAA), flame atomic absorption (AA), cold vapor mercury, cyanide, and other inorganic analyses, which will contain the following information:</b>	
<ol style="list-style-type: none"> <li>Analytical results, including dilutions and re-analysis (Forms I and X)</li> <li>Tentatively identified compounds (TICs) (Form I — VOA and SVOA only)</li> </ol>		<ol style="list-style-type: none"> <li>Environmental samples, including dilutions and re-analysis</li> <li>Initial calibration</li> <li>Initial and continuing calibration verifications</li> <li>Detection limit standards</li> <li>Method blanks, continuing calibration blanks, and preparation blanks</li> <li>ICP interference check samples</li> <li>MS and post-digestion spikes</li> <li>Sample duplicates</li> <li>LCSs</li> <li>Method of standard additions</li> <li>ICP serial dilution</li> </ol>	
<b><u>Section V</u> QC Raw Data - indicated form, plus all raw data</b>		<b><u>Section V</u> Other Raw Data</b>	
<ol style="list-style-type: none"> <li>Method blanks (Form I)</li> <li>MS and MSD samples (Form I)</li> <li>Blank spikes or LCSs (Form I)</li> </ol>		<ol style="list-style-type: none"> <li>Percent moisture for soil samples</li> <li>Sample digestion, distillation, and preparation logs, as necessary</li> <li>Instrument analysis log for each instrument used</li> <li>Standard preparation logs, including initial and final concentrations for each standard used</li> <li>Formula and a sample calculation for the initial calibration</li> <li>Formula and a sample calculation for soil sample results</li> </ol>	
<b><u>Section VI</u> Standard Raw Data - indicated form, plus all raw data</b>			
<ol style="list-style-type: none"> <li>Performance check (Form V)</li> <li>Initial calibrations, with retention-time information (Form VI)</li> <li>Continuing calibrations, with retention-time information (Form VII)</li> <li>Quantitation-limit standard (Form VII-Z)</li> <li>GPC calibration (Form IX)</li> </ol>			
<b><u>Section VII</u> Other Raw Data</b>			
<ol style="list-style-type: none"> <li>Percent moisture for soil samples</li> <li>Sample extraction and cleanup logs</li> <li>Instrument analysis log for each instrument used (Form VIII-Z)</li> <li>Standard preparation logs, including initial and final concentrations for each standard used</li> <li>Formula and a sample calculation for the initial calibration</li> <li>Formula and a sample calculation for soil sample results</li> </ol>			

Notes:

DGI	Data gaps investigation	QC	Quality control
IDL	Instrument detection limit	SAP	Sampling and analysis plan
QA	Quality assurance		

#### **1.6.4 Data Package Format**

The subcontracted laboratory will provide EDDs for all analytical results. An automated laboratory information management system (LIMS) must be used to produce the EDDs. Manual creation of the deliverable (data entry by hand) is unacceptable. The laboratory will verify EDDs internally before they are issued. The EDDs will correspond exactly to the hard-copy data. No duplicate data will be submitted. EDDs will be delivered in a format compatible with Navy Electronic Data Deliverable (NEDD). Results that should be included in all EDDs are as follows:

- Target analyte results for each sample and associated analytical methods requested on the chain-of-custody form
- Method and instrument blanks and preparation and calibration blank results reported for the SDG
- Percent recoveries for the spike compounds in the MS, MSDs, blank spikes, or LCSs
- Matrix duplicate results reported for the SDG
- All reanalysis, reextractions, or dilutions reported for the SDG, including those associated with samples and the specified laboratory QC samples

Electronic and hard-copy data must be retained for a minimum of 3 and 10 years, respectively, after final data have been submitted. The subcontractor will use an electronic storage device capable of recording data for long-term, off-line storage. Raw data will be retained on an electronic data archival system.

#### **1.6.5 Reports Generated**

Separate letter reports for each site (Site 30 and Site 01) will be prepared at the conclusion of the field work and laboratory analyses. For Site 30, the report will include a summary of the results of previous related investigations, field and sampling procedures for the current RI, target analyte concentrations for groundwater and sediment, and associated QC data, conclusions, and recommendations for the site. For Site 01, field and sampling procedures for the RI, target analyte concentrations for groundwater, and associated QC data, will be included in the letter report.

## 2.0 DATA GENERATION AND ACQUISITION

This section describes the requirements for the following:

- Sampling Process Design ([Section 2.1](#))
- Sampling Methods ([Section 2.2](#))
- Sample Handling and Custody ([Section 2.3](#))
- Analytical Methods ([Section 2.4](#))
- QC ([Section 2.5](#))
- Equipment Testing, Inspection, and Maintenance ([Section 2.6](#))
- Instrument Calibration and Frequency ([Section 2.7](#))
- Inspection and Acceptance of Supplies and Consumables ([Section 2.8](#))
- Nondirect Measurements ([Section 2.9](#))
- Data Management ([Section 2.10](#))

### 2.1 SAMPLING PROCESS DESIGN

This section discusses supplemental sampling of sediment and groundwater at the Taylor Boulevard Bridge Disposal Area (Site 30) and Tidal Area Landfill (Site 01). [Section 2.1](#) also includes information on surveying sampling locations.

#### 2.1.1 Debris Cores and Sediment Samples

Five locations were selected at Site 30 for debris borings based on the results of the test pits evaluated in February 2000, which only characterized the debris to 3 feet bgs on the peninsula (see Figure 4). Debris was observed at the bottom of the test pits near the five selected locations. Borings will be advanced to the bottom of the debris to delineate the vertical extent of the debris on the peninsula (see Figure 4). Additionally, for each boring, one sediment sample will be collected directly beneath the debris. A boring log will be completed for each boring.

The locations for the debris bores and sediment samples, sample IDs, and the rationale for selecting these locations are presented in [Table 7](#) and [Figure 4](#). Samples for chemical analysis will be submitted to California state-certified laboratories that have been approved by the Navy. [Table 8](#) summarizes the proposed analytical suite for the environmental, IDW, and QC samples for this project.

**TABLE 7: PROPOSED SAMPLES, RATIONALE, AND ANALYSES**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01),  
Naval Weapons Station Seal Beach Detachment, Concord

Site	Location Name	Total Depth (feet bgs)	Analyses	Sample ID	Sample Media	Sample Depth (feet bgs)	Rationale
30	GW001	NA	Metals, TOC, pH	04530GW001R1	Groundwater	NA	Groundwater not investigated in past site investigations
30	GW002	NA	Metals, TOC, pH	04530GW002R1	Groundwater	NA	Groundwater not investigated in past site investigations
30	GW003	NA	Metals, TOC, pH	04530GW003R1	Groundwater	NA	Groundwater not investigated in past site investigations
30	GW001	NA	Metals, TOC, pH	04530GW001R2	Groundwater	NA	Groundwater not investigated in past site investigations
30	GW002	NA	Metals, TOC, pH	04530GW002R2	Groundwater	NA	Groundwater not investigated in past site investigations
30	GW003	NA	Metals, TOC, pH	04530GW003R2	Groundwater	NA	Groundwater not investigated in past site investigations
30	SB001	TBD	Metals, TOC, pH	04530GW001R1	Sediment	TBD based on depth of debris	Sediment not fully characterized beneath debris in past site investigations
30	SB002	TBD	Metals, TOC, pH	04530GW002R1	Sediment	TBD based on depth of debris	Sediment not fully characterized beneath debris in past site investigations
30	SB003	TBD	Metals, TOC, pH	04530GW003R1	Sediment	TBD based on depth of debris	Sediment not fully characterized beneath debris in past site investigations
30	SB004	TBT	Metals, TOC, pH	04530GW001R2	Sediment	TBD based on depth of debris	Sediment not fully characterized beneath debris in past site investigations
30	SB005	TBT	Metals, TOC, pH	04530GW002R2	Sediment	TBD based on depth of debris	Sediment not fully characterized beneath debris in past site investigations
01	TLSMW001	NA	Metals, SVOCs, VOCs, TPH	04501GW001	Groundwater	NA	Groundwater not investigated since 1998
01	TLSMW002	NA	Metals, SVOCs, VOCs, TPH	04501GW002	Groundwater	NA	Groundwater not investigated since 1998
01	TLSMW003	NA	Metals, SVOCs, VOCs, TPH	04501GW003	Groundwater	NA	Groundwater not investigated since 1998



**TABLE 7: PROPOSED SOIL SAMPLES, RATIONALE, AND ANALYSES (Continued)**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01),  
Naval Weapons Station Seal Beach Detachment, Concord

Site	Location Name	Total Depth (feet bgs)	Analyses	Sample ID	Sample Media	Sample Depth (feet bgs)	Rationale
01	TLSMW004	NA	Metals, SVOCs, VOCs, TPH	04501GW004	Groundwater	NA	Groundwater not investigated since 1998
01	TLSMW005	NA	Metals, SVOCs, VOCs, TPH	04501GW005	Groundwater	NA	Groundwater not investigated since 1998
01	TLSMW006	NA	Metals, SVOCs, VOCs, TPH	04501GW006	Groundwater	NA	Groundwater not investigated since 1998
01	TLSMW007	NA	Metals, SVOCs, VOCs, TPH	04501GW007	Groundwater	NA	Groundwater not investigated since 1998
NA	IDW1	NA	Metals, SVOCs, VOCs, TPH	04530IDW001	Groundwater	NA	Required for proper disposal
NA	IDW2	NA	Metals, SVOCs, VOCs, TPH	04530IDW002	Sediment	NA	Required for proper disposal

Notes:

bgs	Below ground surface
ID	Identification number
IDW	Investigation-derived waste
NA	Not applicable
TBD	To be determined
TPH	Total petroleum hydrocarbon. Includes TPH-purgeable (TPH-p) and TPH-extractable (TPH-e)
TOC	Total organic carbon
SVOC	Semivolatile organic compound
VOC	Volatile organic compound

**TABLE 8: SAMPLES AND INVESTIGATION-DERIVED WASTE ANALYSIS**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01),  
Naval Weapons Station Seal Beach Detachment, Concord

Analytical Methods	Matrix	Field Samples <sup>a</sup>	Equipment Rinsate	Source Water Blank	Field Duplicate	Trip Blank	Total Number of Samples	MS/MSD (at 5%) <sup>b</sup>
<b>Environmental and QC Samples</b>								
Metals	Soil	6	NA	NA	NA	NA	6	1
	Water	14	1	1	1	NA	17	1
VOC	Soil	0	NA	NA	NA	NA	0	NA
	Water	8	1	1	1	1	12	1
SVOC	Soil	0	NA	NA	NA	NA	0	NA
	Water	8	1	1	1	NA	11	1
TPH-Purgeable/ TPH-Extractable	Soil	0	NA	NA	NA	NA	0	NA
	Water	8/8	1	1	1	1	12/12	1
TOC	Soil	5	NA	NA	NA	NA	5	NA
	Water	6	NA	NA	NA	NA	6	NA
pH	Soil	5	NA	NA	NA	NA	5	NA
	Water	6	NA	NA	NA	NA	6	NA

Notes: It is assumed that one composite sample from one drum of soils and one composite water sample will be sufficient to characterize and dispose of the IDW generated during this remedial investigation.

a This table presents the number of samples to be collected. It includes the investigation-derived waste (IDW) samples to be collected for waste characterization.

b Matrix spike and matrix spike duplicates are not considered additional samples.

c Metals will include waste extraction test for analysis of IDW soils.

NA Not applicable

TPH Total petroleum hydrocarbon

QC Quality control

TOC Total organic carbon

SVOC Semivolatile organic compound

VOC Volatile organic compound

### **2.1.2 Investigation of Groundwater**

At Site 30, three groundwater monitoring wells will be installed, and two rounds of sampling will be conducted. The three locations for installation of monitoring wells at Site 30 are selected using professional judgment to evaluate whether debris from the site is contributing to groundwater contamination. One well will be installed up gradient of the debris, and the other two will be installed within the debris field. Because the debris is on the shoreline adjacent to open water, installation of a well downgradient from the site is not feasible.

At Site 01, existing monitoring wells will be sampled to address whether landfill leachate has migrated to groundwater since 1998. Additionally, results will provide information for the design of the upcoming groundwater study for Site 01. Sample IDs and rationale for selecting sampling locations are presented in [Table 7](#). Proposed monitoring well locations for Site 30 are shown on [Figure 4](#). Existing monitoring wells to be sampled at Site 01 are shown on [Figure 3](#). Samples for chemical analysis will be submitted to California state-certified laboratories that have been approved by the Navy. [Table 8](#) summarizes the proposed analytical suite for the environmental, IDW, and QC samples for this project.

### **2.1.3 Rationale for Selecting Analytical Parameters**

The specific analytical parameters specified for each site were selected based on the historical information regarding hazardous material use and the characteristics of wastes potentially disposed of at the site.

The suite of analyses specified for IDW has been selected to be consistent with waste characterization required by disposal facilities.

### **2.1.4 Surveying**

A global positioning system unit that has an accuracy of plus or minus 3 feet will be used to record all monitoring well and debris core locations in the field. Locations will be defined using the State Plane Coordinate System. The sampling location data will be merged with existing sampling location data in the installation database. Vertical coordinates will be reported as feet above mean sea level.

After the monitoring wells have been installed, a professional land surveyor, licensed by the State of California, will survey the location of each well to a precision of 0.10 foot horizontally and the top of casing elevation of each well to a precision of 0.01 foot vertically. Horizontal coordinates shall be established to the closest 0.1 foot and referenced to the California State Plane Coordinate System, Zone 3. Ground surface and all other vertical elevations shall be surveyed to the closest 0.01 foot. These elevations shall be referenced to the National Geodetic Vertical Datum of 1929. The survey data will be merged with existing survey data in the installation database.

### **2.1.5 Underground Utilities Survey**

An underground utilities survey will be conducted to clear all boring locations before any intrusive activities begin. The survey will include water distribution piping, telecommunications lines, storm sewer lines, sanitary sewer lines, industrial wastewater lines, gas lines, fire water lines, fuel product lines, and electrical lines.

## **2.2 SAMPLING METHODS**

This section describes the procedures for sample collection, including sampling methods and equipment, sample preservation requirements, decontamination procedures, and management of IDW.

### **2.2.1 Sampling Methods and Equipment**

Sampling methods and equipment for debris borings and sediment samples and groundwater sampling are provided in the following sections.

#### **2.2.1.1 *Debris Borings and Sediment Samples***

Borings will be installed at five locations at Site 30 to characterize the vertical extent of the debris. Samples will be collected using one of three methods: hydraulic direct-push, manual direct-push, or hand auger. The primary method of collection will be hydraulic direct-push using a bobcat (or other limited access vehicle) with a hydraulic direct-push unit mounted on the end. Sampling equipment will consist of a 12-foot-long, stainless-steel sampler lined with acetate that will be advanced to the bottom of the debris using hydraulic direct-push technology. If refusal is encountered, another boring will be installed as close to the original as possible. Boreholes will be logged following Tetra Tech SOP No. 026 (see [Appendix B](#)).

A sediment sample will be collected from the sediment 6 to 12 inches beneath the debris. Sediment will be placed in an aluminum tray and homogenized with a plastic scoop. Processed sediment will be placed in a 16-ounce glass jar to be sent to the analytical laboratory for analysis of metals, TOC, and pH. The sample IDs and rationale for selecting sampling locations are presented in [Table 7](#). Sampling locations are shown on [Figure 4](#). Samples for chemical analysis will be submitted to California state-certified laboratories that have been approved by the Navy. [Table 8](#) summarizes the proposed analytical suite for the environmental, IDW, and QC samples for this project.

#### **2.2.1.2 *Monitoring Well Installation***

At Site 30, three groundwater monitoring wells will be installed according to procedures specified in Tetra Tech SOP 20, “Monitoring Well Installation” ([Appendix B](#)). A brief description of the procedure for monitoring well installation is outlined in the following text. Monitoring well borings will be installed with 8-1/4-inch, steel, hollow-stem augers. Split-spoon

samples for lithologic logging will be collected continuously from the surface to the total depth of the boring, and a detailed lithologic log of each boring will be prepared during drilling by the field geologist. The wells will be constructed of 4-inch-diameter, schedule 40 polyvinyl chloride (PVC). Well screens will be 10-feet long, 4-inch-diameter, schedule 40 PVC with 0.010-inch slot-size to allow suitable recharge in low-permeability formations and to allow seasonal water table fluctuations. The well screen will intersect the water table, and the top of the well screen will be set at 2 feet above the water table. The filter pack will consist of coarsely graded sand and be installed by pouring from the surface through the interval from 1 foot above and to 1 foot below the well screen. A filter collar of 1 foot of bentonite pellets will be installed at the top of the filter pack, and the annular space from the top of the filter collar to the surface will be filled with cement-bentonite grout, emplaced with a tremmie pipe from the bottom of the open annular space to the surface. The surface completion will be a concrete pad and stove-pipe outer protective casing. If the well is installed in an area where vehicular traffic is expected, 5-foot bumper posts will be installed to protect the well. The wells will be secured with keyed-alike padlocks for well security.

### **2.2.1.3      *Groundwater Sampling***

At Site 30, two rounds of groundwater samples will be conducted. Each well at Site 01 will be sampled once. Low flow-rate purging techniques will be used, where technically feasible, to obtain groundwater samples from wells. Low flow-rate purging will be considered technically infeasible if the water level is more than 25 feet bgs or if the well is unable to support a recharge rate of 0.1 liter per minute as described in the following text. Studies by EPA have shown that low flow-rate purging techniques can be used to obtain more accurate and representative groundwater samples for metals analyses than conventional sampling and filtering techniques (Puls and Powell 1992). A principle objective of low flow-rate purging is to avoid entraining silt- and clay-sized particles in groundwater samples by purging wells at low velocities. Low velocity purging is intended to establish direct flow from the aquifer to the sample container at velocities and flow conditions comparable to *in situ* flow velocities. By using low flow-rate purging techniques, the sampling process more closely matches natural groundwater flow conditions and transport of suspended solids, and analytical problems and uncertainties caused by turbidity are reduced. The field procedure for low flow-rate sampling techniques is described as follows:

1. The breathing zone will be monitored with a photoionization detector during removal of each well cap, and the reading will be compared with the background reading for the site to select the appropriate level of personal protection.
2. The depth to water will be measured with an electric-sounder water level meter to determine the equilibrium water level.
3. A weighted Tygon® or polyethylene tube will be gently lowered into the well to a depth of 3.5 feet below the equilibrium water level or 2 feet below the top of the well screen (whichever is greater) and secured to the outer well casing with tape or plastic ties.

4. Well purging will be initiated slowly and increased gradually to a rate of approximately 0.15 liter per minute (L/min) using a peristaltic pump. Purge water stabilization parameters, including pH, temperature, electrical conductivity, dissolved oxygen, and turbidity, will be measured at intervals of a minimum of 1 liter (L) and recorded on well sampling sheets or in field notebooks. Purge water will be discharged into a graduated cylinder, and the volume of water purged will also be measured and recorded on well sampling sheets. If the drawdown of the water level is 0.3 foot or greater at that pumping rate, procedures 5 and 6 will be initiated. If the water level drawdown is less than 0.3 foot at that pumping rate and the water level is stable, the rate will be increased to the maximum rate at which a static water level is obtained (up to 0.25 L/min), and procedures 7 and 8 will be initiated.
5. When drawdown is more than 0.3 foot at a rate of 0.15 L/min, a modified low-flow purge protocol will be attempted. Using the modified low-flow purge protocol, the pump rate will be increased to a maximum of 1 L/min, and the water level will be drawn down to 1.5 to 3 feet from the equilibrium water level.
6. The pumping rate will then be adjusted within the range of 0.1 to 0.25 L/min until the water level in the well is stable and the recharge rate matches the discharge rate. If the water level continues to decrease at a pumping rate of 0.1 L/min, low flow-rate purging will be considered technically unfeasible, and the well will be purged by the alternative technique described in the following text.
7. The purge water will be considered stabilized after the collection of a minimum of eight measurements (8 L purged) and three successive measurements of each of the stabilization parameters that fall within the following ranges:
 

pH:	$\pm 0.1$
Electrical conductivity:	$\pm 3$ percent microSiemens per centimeter
Temperature:	$\pm 0.5$ °C
Dissolved oxygen:	$\pm 0.2$ milligram per L
Turbidity:	$\pm 15$ percent relative percent difference or three successive measurements of less than 15 nephelometric turbidity units
8. Well stabilization parameters will be expected to asymptotically approach a constant value as the purge water begins to stabilize. If well stabilization parameters are within the ranges specified previously but still appear to be approaching an asymptotic value, well purging will be continued until the purge water appears to be at equilibrium or until a maximum of 20 L has been purged from the well.

In cases where recharge rates in the formation will not allow low flow-rate purging, the wells will be purged dry, allowed to recharge overnight, and sampled the following day, as described in the following list:

1. All water will be purged from the well with disposable Teflon bailers. A weighted Tygon or polyethylene tube will then be gently lowered into the well to a depth of 3.5 feet below the equilibrium water level or the middle of the well screen (whichever is greater) and secured to the outer well casing with tape or plastic ties.
2. The well will be allowed to recharge and will be sampled with a peristaltic pump (if possible) after the well has recovered to within 80 percent of the initial water level, but not later than 24 hours after purging.

Well stabilization parameters, including temperature, pH, electrical conductivity, dissolved oxygen, and turbidity, will be measured immediately before sampling and recorded on well sampling sheets or in field notebooks.

The following procedures will be followed in collecting groundwater samples from monitoring wells after purging has been completed:

1. Measuring and sampling equipment will be decontaminated before samples are collected from each location.
2. During sampling, well purging equipment will be positioned so that potential sources of VOCs, such as vehicles, gasoline engines, or fuel tanks, are downwind of the location of the well or piezometer.
3. When the low flow-rate purging techniques are used or if samples can be collected with a peristaltic pump, water samples will be collected directly from the discharge of the peristaltic pump. If samples cannot be collected with a peristaltic pump, disposable bailers will be used.
4. Groundwater samples collected for metals analysis using bailers will be filtered in the field. The required volume of water will be collected in a laboratory-cleaned, unpreserved, 1-L plastic bottle. The water from the unpreserved bottle will be filtered into a laboratory-cleaned, nitric-acid-preserved, 1-L plastic bottle using a peristaltic pump with an in-line, disposable, 0.45-micron filter.
5. Groundwater samples collected for metals analysis using the peristaltic pump will not be filtered in the field.
6. The 40-milliliter (mL) vials for analyses for VOCs (three for each analysis) will be filled first. After the bottle has been sealed with a Teflon-lined cap, the bottle will be inverted and tapped lightly to check for air bubbles. No air-filled headspace is allowed in the bottles. The bottles for analyses for metals, SVOCs, pesticides, and any other inorganic compounds will be filled last.

Electric-sounder water level meters used during groundwater sampling activities will be decontaminated before each use by washing the probe and the portion of the cable directly above the probe with distilled water and wiping those parts clean with a disposable paper towel.

The required volumes of groundwater will be placed in appropriate sample containers for shipment to the laboratory. Purged water will be placed in 55-gallon drums at the IDW area until the water is transported off site for disposal.

Groundwater samples from Site 30 wells will be analyzed for metals, pH, and TOC. At Site 01, wells will be analyzed for VOCs, SVOCs, TPH, and metals. To achieve analytical detection limits for mercury that are lower than the applicable regulatory criterion, specialized “ultra-clean” sampling methods will be required. Section 8.0 of EPA Method 1669, “Sampling Ambient Water for Determination of Trace Metals at EPA Water Quality Criteria Levels” (included with this document as [Appendix F](#)) details the required sampling methods, which will be followed closely to collect samples for mercury analysis. In brief, Method 1669 involves using specially cleaned containers and sampling equipment, a two-person sampling team with members designated as “dirty-hands” and “clean-hands,” specific functions for each team member, and specific PPE requirements. The “clean-hands” sampling team member handles the sample and all operations involving contact with the sample. The “dirty-hands” sampling team member handles all other functions, such as preparing the sampling equipment and operation of machinery. [Table 7](#) presents the proposed identification numbers for groundwater samples and the rationale for each sampling location.

### **2.2.2 Decontamination**

Drilling and direct push sampling equipment, including rods, augers, split spoon samplers, and the back end of the rig, will be steam cleaned before work begins and between installation of each soil boring. Decontamination of the equipment will follow general practices listed in Tetra Tech SOP 002, “General Equipment Decontamination” ([Appendix B](#)). A portable steam cleaner and potable water will be used for decontamination, and all water derived from decontamination will be collected and temporarily stored on site for characterization. No other equipment will require decontamination.

### **2.2.3 Management of Investigation-Derived Waste**

IDW will include soil cuttings, purged groundwater, and wastewater from decontamination procedures and collection of equipment rinsate samples. The IDW will be containerized in drums.

Ten drums of solid IDW will be generated from installation of the new monitoring wells. One composite IDW soil sample will be obtained from these drums. The soil sample will be analyzed for VOCs, SVOCs, pH, ignitability, reactivity, and WET metals for characterization before disposal.

One drum of wastewater will be generated from each well during well development, and half drum of wastewater will be generated during each sampling event for each well. Water from the first well sampling will be combined with well development waste; therefore, a total of eight drums of wastewater will likely be generated. One composite sample collected from the drum



will be sent to the laboratory for the following analyses: VOCs, SVOCs, pH, TPH, flash point, and metals.

#### **2.2.4 Sample Containers and Holding Times**

The type of sample containers to be used for each analysis, the sample volumes required, the preservation requirements, and the maximum holding times for samples before extraction and analysis are presented in [Table 9](#).

### **2.3 SAMPLE HANDLING AND CUSTODY**

The sections below describe sample-handling procedures, including sample identification and labeling, documentation, chain-of-custody, and shipping.

#### **2.3.1 Sample Identification**

A unique sample ID will be assigned to each sample collected during this project. The sample ID system is designed to be compatible with a computerized data management system that includes previous results for samples collected at this installation. The system allows each sample to be uniquely identified and provides a means of tracking the sample from collection through analysis. The system indicates the DO and site numbers, sampling type, and the location number. For the Geoprobe samples, a number will be added to specify the position of the sample in the vertical sequence. The numbering scheme is illustrated as follows:

<b>DO</b>	045
<b>Site</b>	30
<b>Sampling Activity</b>	SB – Subsurface sediment sample collected from bottom of debris bore GW – groundwater sample
<b>Specific Sampling Location</b>	Specific sampling locations will be numbered consecutively for each specific sampling activity
<b>Sample Depth</b>	The sample depth will be noted on the COC

For example, a sediment sample collected by Geoprobe under DO 045 at Site 30 will be designated 04530SB001.

**TABLE 9: SAMPLE CONTAINER, HOLDING TIME, AND PRESERVATIVE REQUIREMENTS**

Additional Remedial Investigation for the Taylor Boulevard Bridge Disposal Area (Site 30) and the Tidal Area Landfill (Site 01),  
Naval Weapons Station Seal Beach Detachment, Concord

Parameter	Method Number	Sample Volume	Sample Container	Preservative	Holding Time <sup>a</sup>
<b>Soil</b>					
Metals (except mercury)	EPA 6010B/SW-846	2.5 grams	One 16-ounce glass jar with Teflon-lined cap	Cool 4 ± 2°C	180 days
Mercury	EPA 7471A/SW-846	0.2 gram	An aliquot from container for metals analysis	Cool 4 ± 2°C	28 days
pH	EPA 9040/9045A, SW-846	250-mL Jar	Clear Glass with Teflon	Cool 4 ± 2°C	2 days
TOC (Total organic carbon)	Standard Methods 5310B (APHA and others 1992)	250-mL Jar	Clear Glass with Teflon	Cool 4 ± 2°C	28 days
<b>Water</b>					
SVOC	EPA 8270C, SW-846	Two 1-L bottles	Amber glass with Teflon-lined lid	Cool 4 ± 2°C	7 days/40 days
VOC	EPA 8260B, SW-846	Three 40-mL vials	Clear Glass with Teflon	pH < 2 with HCL; Cool 4 ± 2°C	14 days
Metals (except mercury)	EPA 6010B, SW-846	1 Liter	Polyethylene	pH < 2 with HNO <sub>3</sub> ; Cool 4 ± 2°C	6 months
Mercury	EPA 7470A/SW-846	100 mL	An aliquot from the container for metals analysis	pH < 2 with HNO <sub>3</sub> ; Cool 4 ± 2°C	28 days
TPH-Purgeables (gasoline-range organics)	EPA 8015B, SW-846 (with silica gel cleanup)	Two 40-mL vials	Clear Glass with Teflon	pH < 2 with HNO <sub>3</sub> ; Cool 4 ± 2°C	14 days
TPH-Extractables (diesel- and motor oil-range organics)	EPA 8015B, SW-846	Two 1-L	Amber glass with Teflon-lined lid	Cool 4 ± 2°C	7 days/40 days

Notes: More than one analysis can be performed from the same sample container. The sample quantities listed in the table are the quantities necessary if only the specific analysis is requested. The laboratory will indicate which of the analyses can be performed from the same container so that a smaller quantity of sample can be collected at each depth.

Analyses for characterization of investigation-derived waste (IDW) samples are included in the table.

a "x" days/"y" days refers to the maximum number of days from sampling to extraction/the maximum number of days from extraction to analysis

EPA	U.S. Environmental Protection Agency	L	Liter	SVOC	Semivolatile organic compound
HCL	Hydrochloric acid	mL	Milliliter	TPH	Total Petroleum Hydrocarbon
HNO <sub>3</sub>	Nitric acid	MS/MSD	Matrix spike/matrix spike duplicate	VOC	Volatile organic compound

### **2.3.2 Sample Labels**

Field QC samples for this RI are limited to equipment rinsates and source water blanks. One source water blank will be necessary for each source of water used at the site. As the only means of decontamination will be steam cleaning (all other sampling equipment will be disposable), one blank will be collected from the on-site water source used during the event. This blank will be designated the consecutive sample ID at the time it is collected. One equipment rinsate (ER) per day will be required from the Geoprobe sampling equipment. As direct-push sampling is scheduled to last only 1 day, one ER will be collected. The ID for this sample will again be the consecutive sample ID at the time of collection. Additional volume may be required for MS/MSD analysis by the laboratory. No special requirements for nomenclature apply to these samples.

A sample label will be affixed to all sample containers. The label will be completed with the following information, written in indelible ink:

- Project name and location
- Sample identification number
- Date and time of sample collection
- Preservative used
- Sample collector's initials
- Analysis required

After it is labeled, each soil sample will be refrigerated or placed in a cooler that contains ice to maintain the sample temperature at 4 °C, plus or minus 2 °C.

### **2.3.3 Sample Documentation**

Documentation during sampling is essential to ensure proper sample identification. Tetra Tech personnel will adhere to the following general guidelines for maintaining field documentation:

- Documentation will be completed in permanent black ink.
- All entries will be legible.
- Errors will be corrected by crossing out with a single line and then dating and initialing the lineout.
- Any serialized documents will be maintained at Tetra Tech and referenced in the site logbook.
- Unused portions of pages will be crossed out, and each page will be signed and dated.

[Section 1.6.1](#) includes additional information on how Tetra Tech will use logbooks to document field activities. The Tetra Tech field team leader (FTL) is responsible for ensuring that sampling activities are properly documented.

#### **2.3.4 Chain of Custody**

Tetra Tech will use standard sample custody procedures to maintain and document sample integrity during collection, transportation, storage, and analysis. A sample will be considered to be in custody if one of the following statements applies:

- It is in a person's physical possession or view.
- It is in a secure area with restricted access.
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal.

Chain-of-custody procedures provide an accurate written record that traces the possession of individual samples from the time of collection in the field to the time of acceptance at the laboratory. The chain-of-custody record ([Appendix C](#)) also will be used to document all samples collected and the analysis requested. Field personnel will record the following information on the chain-of-custody record:

- Project name and number
- Sampling location
- Name and signature of sampler
- Destination of samples (laboratory name)
- Sample identification number
- Date and time of collection
- Number and type of containers filled
- Analysis requested
- Preservatives used (if applicable)
- Filtering (if applicable)
- Sample designation (grab or composite)
- Signatures of individuals involved in custody transfer, including the date and time of transfer
- Airbill number (if applicable)
- Project contact and phone number

Unused lines on the chain-of-custody record will be crossed out. Field personnel will sign chain-of-custody records that are initiated in the field, and the airbill number will be recorded. The record will be placed in a waterproof plastic bag and taped to the inside of the shipping container used to transport the samples. Signed airbills will serve as evidence of custody transfer between field personnel and the courier as well as between the courier and the laboratory. Copies of the chain-of-custody record and the airbill will be retained and filed by field personnel before the containers are shipped.

Laboratory chain of custody begins when samples are received and continues until samples are discarded. Laboratories analyzing samples under the AECRU contract must follow custody procedures at least as stringent as are required by the EPA CLP SOWs ([EPA 1999a](#), [2000a](#)). The laboratory should designate a specific individual as the sample custodian. The custodian will receive all incoming samples, sign the accompanying custody forms, and retain copies of the forms as permanent records. The laboratory sample custodian will record all pertinent information concerning the samples, including the persons delivering the samples, the date and time received, sample condition at the time of receipt (sealed, unsealed, or broken container; temperature; or other relevant remarks), the sample identification numbers, and any unique laboratory identification numbers for the samples. This information should be entered into a computerized LIMS. When the sample transfer process is complete, the custodian is responsible for maintaining internal logbooks, tracking reports, and other records necessary to maintain custody throughout sample preparation and analysis.

The laboratory will provide a secure storage area for all samples. Access to this area will be restricted to authorized personnel. The custodian will ensure that samples requiring special handling, including samples that are heat- or light-sensitive, radioactive, or have other unusual physical characteristics, will be properly stored and maintained prior to analysis.

### **2.3.5 Sample Shipment**

The following procedures (also outlined in SOP No. 19) will be implemented when samples collected during this project are shipped:

- The cooler will be filled with bubble wrap, sample bottles, and packing material. Sufficient packing material will be used to prevent sample containers from breaking during shipment. Enough ice will be added to maintain the sample temperature of below 4 °C, plus or minus 2 °C.
- The chain-of-custody records will be placed inside a plastic bag. The bag will be sealed and taped to the inside of the cooler lid. The air bill, if required, will be filled out before the samples are handed over to the carrier. The laboratory will be notified if the sampler suspects that the sample contains any substance that would require laboratory personnel to take safety precautions.
- The cooler will be closed and taped shut with strapping tape around both ends. If the cooler has a drain, it will be taped shut both inside and outside of the cooler.

- Signed and dated custody seals will be placed on the front and side of each cooler. Wide clear tape will be placed over the seals to prevent accidental breakage.
- The chain-of-custody record will be transported within the taped sealed cooler. When the cooler is received at the analytical laboratory, laboratory personnel will open the cooler and sign the chain-of-custody record to document transfer of samples.

Multiple coolers may be sent in one shipment to the laboratory. The outside of the coolers will be marked to indicate the number of coolers in the shipment.

## 2.4 ANALYTICAL METHODS

[Table 9](#) presents the analytical methods that will be used to analyze samples collected during this project, and [Appendix A](#) presents the MQOs and control limits for sample analysis. [Tables D-1](#) through [D-3](#) in [Appendix D](#) present the individual target analytes for this RI and their associated PRRLs. The analytical laboratories will attempt to achieve the PRRLs for all the investigative samples collected. If problems occur in achieving the PRRLs, the laboratories will contact the Tetra Tech analytical coordinator immediately, and other alternatives will be pursued (such as analyzing an undiluted aliquot and allowing nontarget compound peaks to go off scale) to achieve acceptable reporting limits. In addition, results below the reporting limit but above the MDL will be reported with appropriate flags to indicate the greater uncertainty associated with these values.

The analytical methods required for this RI are all EPA SW-846 methods ([EPA 1996](#)). Protocols for laboratory selection and for ensuring laboratory compliance with project analytical and QA/QC requirements are presented in the following sections.

### 2.4.1 Selection of Analytical Laboratories

Laboratories for this RI will be selected from a list of prequalified laboratories developed by Tetra Tech to support Navy contracts. Prequalification streamlines laboratory selection by reducing the need to compile and review detailed bid and qualification packages for each individual investigation. Prequalification also improves flexibility in the program by allowing analyses to be directed to a number of different capable laboratories with available capacity at the time samples are collected.

Tetra Tech's laboratory prequalification and selection process relies on (1) a standard procedure to evaluate and prequalify laboratories for work under the contract, and (2) the "Tetra Tech EM Inc. Laboratory Analytical Statement of Work" for Navy contracts ([Tetra Tech 2002a](#)). The Tetra Tech SOW is a contractual document that specifies standard requirements for analyses routinely conducted. Tetra Tech establishes a basic ordering agreement that incorporates and enforces the laboratory SOW with each prequalified laboratory. Individual purchase orders can then be written for specific investigations. These aspects of laboratory selection are further described in the following sections, along with Tetra Tech's procedures for selecting laboratories

when the laboratory SOW does not specifically address project-specific analytical methods or QC requirements.

#### **2.4.1.1      *Laboratory Evaluation and Prequalification***

Laboratories that support the Navy either directly or through subcontracts are evaluated and approved for Navy use by the Naval Facilities Engineering Service Center (NFESC). Laboratories that support Tetra Tech under Navy contracts have been selected from the list of laboratories approved by NFESC and evaluated by Tetra Tech to assure that the laboratory can meet the technical requirements of the laboratory SOW and produce data of acceptable quality. The evaluation of the laboratories is conducted in accordance with the NFESC *Installation Restoration Chemical Data Quality Manual* (IRCDQM) (NFESC 1999). The laboratory evaluation includes the following elements:

- **Certification and approval.** Laboratories must be currently certified by the California Department of Health Services (DHS) Environmental Laboratory Accreditation Program (ELAP) for analysis of hazardous materials for each method specified. Laboratories must also have or obtain similar approval from NFESC. The California DHS ELAP certification and NFESC approval must be obtained before the laboratory begins work.
- **Performance evaluation (PE) samples.** Each laboratory must initially and yearly demonstrate its ability to satisfactorily analyze single-blind PE samples for all analytical services it will provide under Navy contracts. At its discretion, Tetra Tech may submit one or more double-blind PE samples at Tetra Tech's cost. When the results for the PE sample are deficient, the laboratory must correct any problems and analyze (at its own cost) a subsequent round of PE samples for the deficient analysis.
- **Audits.** Laboratories must initially and yearly demonstrate their qualifications by submitting to one or more audits by Tetra Tech. The audits may consist of (1) an on-site review of laboratory facilities, personnel, documentation, and procedures, or (2) an off-site review of hardcopy and electronic deliverables, or magnetic tapes. When deficiencies are identified, the laboratory must correct the problem and provide Tetra Tech with a written summary of the corrective action taken.

[Appendix E](#) provides a current list of subcontractor laboratories that have passed this evaluation program. Each laboratory was evaluated before it was added to the list, and each is reevaluated annually. If a laboratory fails to meet any of the evaluation criteria, it is removed from the list of approved laboratories.

#### **2.4.1.2      *Laboratory Statement of Work***

The laboratory SOW establishes standard requirements for the analytical methods most commonly used under Navy contracts. For each method, the laboratory SOW specifies standard method-specific target analyte lists and PRRLs; QC samples and associated control limits;

calibration requirements; and miscellaneous method performance requirements. The laboratory SOW also specifies standard data package requirements, EDD formats, data qualifiers, and delivery schedules. In addition, the laboratory SOW outlines support services (such as providing sample containers, trip blanks, temperature blanks, sample coolers, and custody forms and seals) that are expected of laboratories. The laboratory SOW incorporates Navy QA policy as well as applicable EPA and state QA guidelines, as appropriate.

Tetra Tech's laboratory SOW addresses the EPA CLP methods for VOCs, SVOCs, pesticides, PCBs, metals, and cyanide, as well as non-CLP methods for a variety of organic, inorganic, and physical parameters. Non-CLP methods include the methods published by EPA in SW-846 and in "Methods for Chemical Analysis of Water and Waste" (EPA 1983); American Society for Testing and Materials methods; and those published by the American Public Health Association (APHA), American Water Works Association, and Water Pollution Control Federation in "Standard Methods for the Examination of Water and Waste Water" (APHA and others 1992). Laboratories on the approved laboratory list can elect to provide a portion of the analytical services specified in the laboratory SOW.

As noted previously, the laboratory SOW is incorporated into all laboratory subcontracts established for analytical services supporting Navy projects. Thus, the prequalified laboratories commit to meeting the requirements in the laboratory SOW during the contracting process before they receive samples. Tetra Tech reviews and revises the laboratory SOW regularly to incorporate new methods and requirements, modifications or updates to existing methods, changes in Navy QA policy or regulatory requirements, and any other necessary corrections or revisions.

#### **2.4.1.3      *Laboratory Selection and Oversight***

After project-specific analytical and QA/QC requirements have been identified and documented in the SAP, the Tetra Tech analytical coordinator works closely with a Tetra Tech procurement specialist to select a laboratory that can meet these requirements. When project-specific analytical and QC requirements are consistent with Tetra Tech's laboratory SOW, the analytical coordinator identifies one or more prequalified subcontractor laboratories capable of carrying out the work. As part of this process, the analytical coordinator typically contacts the laboratories to discuss the analytical requirements and project schedule. The analytical coordinator then forwards the name of the recommended laboratory (or laboratories) to the Tetra Tech procurement specialist, who issues a purchase order for the work. When analytical requirements are consistent with Tetra Tech's laboratory SOW and multiple prequalified laboratories are capable of performing the work, a specific laboratory is typically selected based on laboratory workload and project schedule considerations.

Tetra Tech follows a similar procedure when project-specific analytical and QC requirements are nonstandard and differ from those specified in Tetra Tech's laboratory SOW. The analytical coordinator contacts analytical laboratories, beginning with those on Tetra Tech's prequalified list, to discuss the analytical and QA/QC requirements in the SAP and to assess the laboratories' ability to meet the requirements. In many cases, Tetra Tech works cooperatively with analytical



laboratories to develop and refine appropriate QC requirements for nonstandard analyses or matrixes.

If the analytical coordinator is unable to identify one or more prequalified laboratories that can perform the work, additional laboratories are contacted. In general, the additional laboratories must be evaluated as described in [Section 2.4.1.1](#) before they will be allowed to analyze any samples, although some steps in the evaluation may be waived for certain investigations and circumstances (for example, unusual analytes, urgent project needs, experimental methods, mobile laboratories, or on-site screening analyses). After additional laboratories have been identified, the analytical coordinator forwards their names to the procurement specialist. The procurement specialist prepares a solicitation package, including the project-specific analytical and QC requirements, and submits the package to the laboratories. The procurement specialist, in cooperation with the analytical coordinator and project manager, then evaluates the proposals received and selects a laboratory that meets the requirements and provides the best value to the Navy and Tetra Tech. Finally, the procurement specialist issues a purchase order to the selected laboratory that incorporates the project-specific analytical and QA/QC requirements.

After a laboratory has been selected, the analytical coordinator holds a kickoff meeting with the laboratory project manager. The kickoff meeting is held regardless of whether project-specific analytical and QA/QC requirements are consistent with Tetra Tech's laboratory SOW or are outside the SOW. The Tetra Tech project manager, procurement specialist, and other key project and laboratory staff may also be involved in this meeting. The kickoff meeting includes a review of analytical and QC requirements in the SAP, the project schedule, and any other logistical support that the laboratory will be expected to provide.

## **2.4.2 Project Analytical Requirements**

For this field investigation, one or more prequalified subcontractor laboratories will analyze samples of soil and water off site. The laboratories will be selected before the field program begins based on their ability to meet the project analytical and QC requirements as well as their ability to meet the project schedule. The analytical methods selected for the field investigations at TBB Site 30 and TA Site 01 at NWSSB Detachment Concord are standard EPA methods that are described in Tetra Tech's laboratory SOW. All methods are listed in [Table 9](#) and are from EPA's SW-846 "Test Methods for Evaluating Solid Waste" (EPA 1996).

This SAP documents project-specific QC requirements for the selected analytical methods. Sample volume, preservation, and holding time requirements are specified in [Table 9](#). Requirements for laboratory QC samples are described in [Table 4](#) and in [Section 2.5](#). [Appendix A](#) includes project-specific precision and accuracy goals for the methods. Finally, PRRLs for each method are documented in [Appendix D](#).

## **2.5 QUALITY CONTROL**

Tetra Tech will assess the quality of field data through regular collection and analysis of field QC samples. Laboratory QC samples will also be analyzed in accordance with referenced analytical method protocols to ensure that laboratory procedures are conducted properly and that the quality of the data is known.

### **2.5.1 Field Quality Control Samples**

QC samples are collected in the field and analyzed to check sampling and analytical precision, accuracy, and representativeness. The following section discusses the types and purposes of field QC samples that will be collected for this project. [Table 10](#) summarizes the types and frequency of collection of field QC samples.

#### **2.5.1.1 Field Duplicates**

Field duplicate samples are collected at the same time and from the same source and then submitted as separate samples to the laboratory for analysis. Although field duplicate sediment samples are sometimes collected as sediment samples from adjacent locations, duplicate samples for sediment will not be collected for this project for two reasons. First, because adjacent sediment samples incorporate some spatial variability, these samples cannot be used directly to assess sampling precision. Furthermore, it is not practical to set QC limits for the RPD of these samples, which precludes their use for QC purposes. Second, while the information on spatial variability that can be obtained from adjacent soil samples may be useful in assessing or implementing remedial options, no objectives relating to these data uses have been identified for this project. Field duplicates will be collected for groundwater at a rate of 10 percent.

#### **2.5.1.2 Trip Blanks**

Trip blanks should demonstrate that contamination is not originating from sample containers or from any factor during sample transport. A trip blank originates at the laboratory as a 40-milliliter vial typically used for VOC and TPH as purgeables analysis. The vial is filled at the laboratory with reagent-grade, organic-free water. The trip blanks are then transported to the site with the empty containers that will be used for sample collection. The trip blanks are stored at the site until the proposed field samples have been collected. One trip blank will accompany each sample transport container that holds water samples for volatile analysis, such as VOCs and TPH as purgeables analysis back to the laboratory. The trip blank is not opened until it is returned to the laboratory. Trip blanks will be analyzed only for VOCs.

**TABLE 10: FIELD QUALITY CONTROL SAMPLES**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

Sample Type		Frequency of Analysis	Matrix
Matrix spike and matrix spike duplicate	5 percent <sup>a</sup>		Soil
Field duplicate	10 percent		Water
Equipment rinsate	One per day per team per type of reusable sampling tool used <sup>c</sup>		Water
Source water blank	One per each water source used for decontamination		Water
Trip blank	One per sample transport container that holds water samples for VOC or TPH-purgeables		Water

Notes:

- a Matrix spikes and matrix spike duplicates (MS/MSD) for soil samples will be selected by the laboratory. Matrix duplicates replace MSDs for inorganic analyses.
- b Tetra Tech EM Inc. (Tetra Tech) anticipates that no field blanks will be required during this remedial investigation.
- c Tetra Tech anticipates that 1 day will be sufficient to install all four soil borings; consequently, only one rinsate sample will be collected for this remedial investigation.

### **2.5.1.3 Equipment Rinsate Samples**

Equipment rinsate samples will be collected during soil sampling at a frequency of once per day of sampling per team per type of tool used. An equipment rinsate is a sample collected after a sampling device is subjected to standard decontamination procedures. Water will be poured over or through the sampling equipment into a sample container and sent to the laboratory for analysis. Analytically certified, organic-free water or equivalent will be used for organic parameters; deionized or distilled water will be used for inorganic parameters.

During data validation, the results for the equipment rinsate samples will be used to qualify data or to evaluate the levels of analytes in the field samples collected on the same day.

### **2.5.1.4 Source Water Blank Samples**

One source water blank will be collected for each sampling event and for each source of water (distilled, deionized, or from an industrial or residential water source).

## **2.5.2 Laboratory Quality Control Samples**

The types of laboratory QC samples that will be used for this project are discussed in the following sections. [Table 4](#) presents the required frequencies for laboratory QC samples, and [Appendix A](#) presents project-specific precision and accuracy goals for these samples.

#### **2.5.2.1      *Method Blanks***

Method blanks will be prepared at the frequency prescribed in the individual analytical method or at a rate of 5 percent of the total samples if a frequency is not prescribed in the method.

#### **2.5.2.2      *Matrix Spike and Matrix Spike Duplicates***

MS/MSD samples for water matrices require collection of an additional volume of material for laboratory spiking and analysis; for soil matrices, additional sample volume is generally not required. MS/MSD samples will be collected at a frequency of 5 percent for soil. The percent recoveries will be calculated for each of the spiked analytes and used to evaluate analytical accuracy. The RPD between spiked samples will be calculated to evaluate precision. Project-specific precision and accuracy goals are presented in [Appendix A](#).

#### **2.5.2.3      *Laboratory Control Samples***

LCSs, or blank spikes, will be analyzed at the frequency prescribed in the analytical method or at a rate of 5 percent of the total samples if a frequency is not prescribed in the method. If percent recovery results for the LCS or blank spike are outside of the established goals, laboratory-specific protocols will be followed to gauge the usability of the data.

#### **2.5.2.4      *Surrogate Standards***

Surrogate standards consist of known concentrations of nontarget organic analytes that are added to each sample, method blank, and MS/MSD before samples are prepared and analyzed. The surrogate standard measures the efficiency the analytical method in recovering the target analytes from an environmental sample matrix. Percent recoveries for surrogate compounds are evaluated using laboratory control limits. Surrogate standards provide an indication of laboratory accuracy and matrix effects for every field and QC sample analyzed by gas chromatography for volatile and extractable organic constituents. Surrogate compounds are used in the analysis of VOCs to monitor purge efficiency and analytical performance, whereas surrogates are used in the analysis of extractable organic compounds to monitor the extraction process and analytical performance.

#### **2.5.2.5      *Internal Standards***

Internal standards are compounds that are added to every VOC and SVOC standard, method blank, MS/MSD, and sample or sample extract at a known concentration before analysis. Internal standards are used as the basis for quantification of gas chromatography and mass spectrometry (GC/MS) target compounds and ensure that the GC/MS sensitivity and response are stable during the analytical run. An internal standard is used to evaluate the efficiency of the sample introduction process and monitors the efficiency of the analytical procedure for each sample matrix encountered. Internal standards may also be used in the analysis of organic compounds by GC to monitor retention-time shifts. Validation of internal standards data will be based on EPA protocols presented in guidelines for evaluating organic analyses ([EPA 1999b](#)).

### **2.5.3 Additional Laboratory Quality Control Procedures**

In addition to the analysis of laboratory QC samples, subcontractor laboratories will conduct the QC procedures discussed in the following sections.

#### **2.5.3.1 Method Detection Limit Studies**

The MDL is the minimum concentration of a compound that can be measured and reported. The MDL is a specified limit at which there is 99 percent confidence that the concentration of the analyte is greater than zero. The MDL takes into account sample matrix and preparation. The subcontractor laboratory will demonstrate the MDLs for all analyses except inorganic analyses and physical properties test methods.

MDL studies will be conducted annually for soil matrices, or more frequently if any method or instrumentation changes. Each MDL study will consist of seven replicates spiked with all target analytes of interest at concentrations no greater than required quantitation limits. The replicates will be extracted and analyzed in the same manner as routine samples. If multiple instruments are used, each will be included in the MDL study. The MDLs reported will be representative of the least sensitive instrument.

#### **2.5.3.2 Sample Quantitation Limits**

Sample quantitation limits (SQL), also referred to as practical quantitation limits, are PRRLs adjusted for the characteristics of individual samples. The PRRLs presented in [Appendix D](#) are chemical-specific levels that a laboratory should be able to routinely detect and quantitate in a given sample matrix. The PRRL is usually defined in the analytical method or in laboratory method documentation. The SQL takes into account changes in the preparation and analytical methodology that may alter the ability to detect an analyte, including changes such as use of a smaller sample aliquot or dilution of the sample extract. Physical characteristics such as sample matrix and percent moisture that may alter the ability to detect the analyte are also considered. The laboratory will calculate and report SQLs for all environmental samples.

#### **2.5.3.3 Control Charts**

Control charts document data quality in graphic form for specific method parameters such as surrogate standards and blank spike recoveries. A collection of data points for each parameter is used to statistically calculate means and control limits for a given analytical method. This information is useful in determining whether analytical measurement systems are in control. In addition, control charts provide information about trends over time in specific analytical and preparation methodologies. Although they are not required, Tetra Tech recommends that subcontractor laboratories maintain control charts for organic and inorganic analyses. At a minimum, method-blank surrogate recoveries and blank spike recoveries should be charted for all organic methods. Blank spike recoveries should be charted for inorganic methods. Control charts should be updated monthly.

## **2.6 EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE**

This section outlines the testing, inspection, and maintenance procedures that will be used to keep both field and laboratory equipment in good working condition.

### **2.6.1 Maintenance of Field Equipment**

Preventive maintenance for most field equipment is carried out in accordance with procedures and schedules recommended in (1) the equipment manufacturer's literature or operating manual or (2) SOPs that describe equipment operation associated with particular applications of the instrument. More stringent testing, inspection, and maintenance procedures and schedules may be required when field equipment is used to make critical measurements.

A field instrument that is out of order will be segregated, clearly marked, and not used until it is repaired. The FTL will be notified of equipment malfunctions so that service can be completed quickly or substitute equipment can be obtained. When the condition of equipment is suspect, unscheduled testing, inspection, and maintenance should be conducted. Any significant problems with field equipment will be reported in the daily field QC report.

A Geoprobe will be used to collect soil samples during the field investigation Sites 30 and 01 at NWSSB Detachment Concord. The Geoprobe subcontractor will be required to provide detailed written procedures for inspecting, maintaining, and servicing field equipment that will be available on site.

### **2.6.2 Maintenance of Laboratory Equipment**

Subcontractor laboratories will prepare and follow a maintenance schedule for each instrument used to analyze samples collected for this project. All instruments will be serviced at scheduled intervals necessary to optimize factory specifications. Routine preventive maintenance and major repairs will be documented in a maintenance logbook.

An inventory of items to be kept ready for use in case of instrument failure will be maintained and restocked as needed. The list will include equipment parts subject to frequent failure, parts that have a limited lifetime of optimum performance, and parts that cannot be obtained in a timely manner.

The laboratory's QA plan and written SOPs will describe specific preventive maintenance procedures for equipment maintained by the laboratory. These documents identify the personnel responsible for major, preventive, and daily maintenance procedures, the frequency and type of maintenance performed, and procedures for documenting maintenance activities.

Laboratory equipment malfunctions will require immediate corrective action. Actions should be documented in laboratory logbooks. No other formal documentation is required unless data quality is adversely affected or further corrective action is necessary. On-the-spot corrective actions will be taken as necessary in accordance with the procedures described in the laboratory QA plan and SOPs.

## **2.7 INSTRUMENT CALIBRATION AND FREQUENCY**

The following sections discuss calibration procedures that will be followed to ensure the accuracy of measurements made using field and laboratory equipment.

### **2.7.1 Calibration of Field Equipment**

Field equipment, if used, will be calibrated at the beginning of the field effort and at prescribed intervals. The calibration frequency depends on the type and stability of equipment, the intended use of the equipment, and the recommendation of the manufacturer. Detailed calibration procedures for field equipment are available from the specific manufacturers' instruction manuals, and general guidelines are included in Tetra Tech SOPs. All calibration information will be recorded in a field logbook or on field forms. A label that specifies the scheduled date of the next calibration will be attached to the field equipment. If this type of identification is not feasible, equipment calibration records will be readily available for reference.

### **2.7.2 Calibration of Laboratory Equipment**

Procedures and frequencies for calibration of laboratory equipment will follow the requirements in the methods referenced in [Section 2.4.2](#) of this SAP. Qualified analysts will calibrate laboratory equipment and document the procedures and results in a logbook.

The laboratory will obtain calibration standards from commercial vendors for both inorganic and organic compounds and analytes. Stock solutions for surrogate standards and other inorganic mixes will be made from reagent-grade chemicals or as specified in the analytical method. Stock standards will also be used to make intermediate standards that will be used to prepare calibration standards. Special attention will be paid to expiration dating, proper labeling, proper refrigeration, and freedom from contamination. Documentation on receipt, mixing, and use of standards will be recorded in the appropriate laboratory logbook. Logbooks must be permanently bound. Additional specific handling and documentation requirements for the use of standards may be provided in subcontractor laboratory QA plans.

## **2.8 INSPECTION AND ACCEPTANCE OF SUPPLIES AND CONSUMABLES**

Tetra Tech project managers have primary responsibility for identifying the types and quantities of supplies and consumables needed to complete Navy projects and are responsible for determining acceptance criteria for these items.

Supplies and consumables can be received either at a Tetra Tech office or at a work site. When supplies are received at an office, the project manager or field team leader will sort them according to vendor, check packing slips against purchase orders, and inspect the condition of all supplies before they are accepted for use on a project. If an item does not meet the acceptance criteria, deficiencies will be noted on the packing slip and purchase order, and the item will then be returned to the vendor for replacement or repair.

Procedures for receiving supplies and consumables in the field are similar. When supplies are received, the Tetra Tech project manager or field team leader will inspect all items against the acceptance criteria. Any deficiencies or problems will be noted in the field logbook, and deficient items will be returned for immediate replacement.

Analytical laboratories are required to provide certified clean containers for all analyses. These containers must meet EPA standards described in “Specifications and Guidance for Obtaining Contaminant-Free Sampling Containers” ([EPA 1992](#)).

## **2.9 NONDIRECT MEASUREMENTS**

No data for project implementation or decision-making will be obtained from nondirect measurement sources.

## **2.10 DATA MANAGEMENT**

Field and analytical data collected from this project and other environmental investigations at NWSSB Detachment Concord are critical to site characterization efforts, development of the comprehensive conceptual site model, risk assessments, and selection of remedial actions to protect human health and the environment. An information management system is necessary to ensure efficient access so that decisions based on the data can be made in a timely manner.

After the field and laboratory data reports are reviewed and validated, the data will be entered into Tetra Tech’s database for NWSSB Detachment Concord. The database contains data for (1) summarizing observations on contamination and geologic conditions, (2) preparing reports and graphics, (3) using with geographic information systems, and (4) transmitting in an electronic format compatible with NEDD. The following sections describe Tetra Tech’s data tracking procedures, data pathways, and overall data management strategy for NWSSB Detachment Concord.

### **2.10.1 Data Tracking Procedures**

All data generated in support of the Navy program at NWSSB Detachment Concord are tracked through a database created by Tetra Tech. Information related to the receipt and delivery of samples, project order fulfillment, and invoicing for laboratory and validation tasks is stored in the Tetra Tech program, SAMTRAK. All data are filed according to the document control number.



### **2.10.2 Data Pathways**

Data are generated from three primary pathways at NWSSB Detachment Concord—field activities, laboratory analysis, and validation. Data from all three pathways must be entered into the NWSSB Detachment Concord database. Data pathways must be established and well documented to evaluate whether the data have been accurately loaded into the database in a timely manner.

Data generated during field activities are recorded using field forms ([Appendix C](#)). The analytical coordinator or field team leader reviews these forms for completeness and accuracy. Data from the field forms, including the chain-of-custody form, are entered into SAMTRAK according to the document control number.

Data generated during laboratory analysis are recorded in hard copy and in EDDs after the samples have been analyzed. The laboratory will send the hard copy and EDD records to the analytical coordinator. The analytical coordinator reviews the data deliverable for completeness, accuracy, and format. After the format has been approved, the electronic data are manipulated and downloaded into the NWSSB Detachment Concord database. Tetra Tech data entry personnel will then update SAMTRAK with the total number of samples received and number of days required to receive the data.

After validation, the analytical coordinator reviews the data for accuracy. Tetra Tech will then update the NWSSB Detachment Concord database with the appropriate data qualifiers. SAMTRAK is also updated to record associated laboratory and data validation costs.

### **2.10.3 Data Management Strategy**

Tetra Tech's short- and mid-term data management strategies require that the database for NWSSB Detachment Concord be updated monthly. The data consist of chemical and field data from Navy contractors, entered into an Oracle (Version 7.3) database. The database can be used to generate reports using available computer-aided drafting and design and contouring software. All electronic data from this database will be stored and maintained in a format compatible with NEDD.

To satisfy long-term data management goals, the data will be loaded into the database at Tetra Tech for storage, further manipulation, and retrieval after laboratory and field reports are reviewed and validated. The database will be used to provide data for chemical and geologic analysis and for preparing reports and graphic representations of the data. Additional data acquired from field activities are recorded on field forms ([Appendix C](#)) reviewed for completeness and accuracy by the analytical coordinator or field team leader. Hard copies of forms, data, and chain-of-custody forms are filed in a secure storage area according to project and document control numbers. Laboratory data packages and reports will be archived at Tetra Tech or Navy offices. Laboratories that generated the data will archive hard-copy data for a minimum of 10 years.

### **3.0 ASSESSMENT AND OVERSIGHT**

This section describes the field and laboratory assessments that may be conducted during this project, the individuals responsible for conducting assessments, corrective actions that may be implemented in response to assessment results, and the way quality-related issues will be reported to Tetra Tech and Navy management.

#### **3.1 ASSESSMENT AND RESPONSE ACTIONS**

Tetra Tech and the Navy will oversee collection of environmental data using the assessment and audit activities described in the following text. Any problems encountered during an assessment of field investigation or laboratory activities will require appropriate corrective action to ensure that the problems are resolved. This section describes the types of assessments that may be completed, Tetra Tech and Navy responsibilities for conducting the assessments, and corrective action procedures to address problems identified during an assessment.

##### **3.1.1 Field Assessments**

Tetra Tech conducts field technical systems audits (TSA) on selected Navy projects to support data quality and encourage continuous improvement in the field systems that involve environmental data collection. The Tetra Tech QA program manager selects projects for field TSAs quarterly based on available resources and the relative significance of the field sampling effort. During the field TSA, the assessor will use personnel interviews, direct observations, and reviews of project-specific documentation to evaluate and document whether procedures specified in the approved SAP are being implemented. The following specific items may be observed during the TSA:

- Availability of approved project plans such as this SAP and the HASP ([Tetra Tech 1998b](#))
- Documentation of personnel qualifications and training
- Sample collection, identification, preservation, handling, and shipping procedures
- Sampling equipment decontamination
- Equipment calibration and maintenance
- Completeness of logbooks and other field records (including nonconformance documentation)

During the TSA, the Tetra Tech assessor will verbally communicate any significant deficiencies to the FTL for immediate correction. These and all other observations and comments will also be documented in a TSA report. The TSA report will be issued to the Tetra Tech project manager, FTL, program QA manager, and project QA officer in e-mail format within 7 days after the TSA is completed.

The Tetra Tech program QA manager determines the timing and duration of TSAs. Generally, TSAs are conducted early in the project so that any quality issues can be resolved before large amounts of data are collected.

The Navy QA officer may also independently conduct a field assessment of any Tetra Tech project. Items reviewed by the Navy QA officer during a field assessment may be similar to those described previously.

### **3.1.2 Laboratory Assessments**

As described in [Section 2.4.1](#), NFESC assesses all laboratories before they are allowed to analyze samples under Navy contracts. Tetra Tech also conducts a preaward assessment of each laboratory before they are placed on the approved list for performing work under the AECRU contract ([Appendix E](#)). These assessments include (1) reviews of laboratory certifications, (2) initial and annual demonstrations of the laboratory's ability to satisfactorily analyze single-blind PE samples, and (3) laboratory audits. Laboratory audits may consist of an on-site review of laboratory facilities, personnel, documentation, and procedures, or an off-site evaluation of the ability of the laboratory's data management system to meet contract requirements. Tetra Tech also conducts an assessment when an approved laboratory has been selected for nonroutine analyses or when a laboratory that is not on the approved list must be used.

Tetra Tech will conduct a TSA of the selected laboratory for this project after the laboratory receives and begins processing samples. The purpose of this TSA will be to review the project-specific implementation of the methods specified in this SAP and to ensure that appropriate QC procedures are being implemented in association with these methods.

The Navy may audit any laboratory that will analyze samples on this project. The Navy QA officer will determine the need for these audits and will typically conduct the audits before samples are submitted to the laboratory for analysis.

### **3.1.3 Assessment Responsibilities**

Tetra Tech personnel who conduct assessments will be independent of the activity evaluated. The Tetra Tech program QA manager will select the appropriate personnel to conduct each assessment and will assign them responsibilities and deadlines for completing the assessment. These personnel may include the program QA manager, project QA officer, or senior technical staff with relevant expertise and experience in assessment.

When an assessment is planned, the Tetra Tech program QA manager selects a lead assessor who is responsible for the following:

- Selecting and preparing the assessment team
- Preparing an assessment plan
- Coordinating and scheduling the assessment with the project team, subcontractor, or other organization being evaluated
- Participating in the assessment
- Coordinating preparation and issuance of assessment reports and corrective action request forms
- Evaluating responses and resulting corrective actions.

After a TSA is completed, the lead assessor will submit an audit report to the Tetra Tech program QA manager, project manager, and project QA officer; other personnel may be included in the distribution as appropriate. Assessment findings will also be included in the quality control summary report (QCSR) for the project ([Section 3.2.3](#)).

The Navy QA officer is responsible for coordinating all audits that may be conducted by Navy personnel under this project. Audit preparation, completion, and reporting responsibilities for Navy auditors would be similar to those described previously.

#### **3.1.4 Field Corrective Action Procedures**

Field corrective action procedures will depend on the type and severity of the finding. Tetra Tech classifies assessment findings as either deficiencies or observations. Deficiencies are findings that may have a significant impact on data quality and that will require corrective action. Observations are findings that do not directly affect data quality, but are suggestions for consideration and review.

As described in [Section 3.1.1](#), project teams are required to respond to deficiencies identified in TSA reports. The project manager, FTL, and project QA officer will discuss the deficiencies and the appropriate steps to resolve each deficiency as follows:

- Determining when and how the problem developed
- Assigning responsibility for problem investigation and documentation
- Selecting the corrective action to eliminate the problem
- Developing a schedule for completing the corrective action

- Assigning responsibility for implementing the corrective action
- Documenting and verifying that the corrective action has eliminated the problem
- Notifying the Navy of the problem and the corrective action taken

In responding to the TSA report, the project team will include a brief description of each deficiency, the proposed corrective action, the individual responsible for determining and implementing the corrective action, and the completion dates for each corrective action. The project QA officer will use a status report to monitor all corrective actions.

The Tetra Tech program QA manager is responsible for reviewing proposed corrective actions and verifying that they have been effectively implemented. The program QA manager can require data acquisition to be limited or discontinued until the corrective action is complete and a deficiency is eliminated. The program QA manager can also request the reanalysis of any or all samples and a review of all data acquired since the system was last in control.

### **3.1.5 Laboratory Corrective Action Procedures**

Internal laboratory procedures for corrective action and descriptions of out-of-control situations that require corrective action are contained in laboratory QA plans. At a minimum, corrective action will be implemented when any of the following three conditions occurs: control limits are exceeded, method QC requirements are not met, or sample-holding times are exceeded. The laboratory will report out-of-control situations to the Tetra Tech analytical coordinator within 2 working days after they are identified. In addition, the laboratory project manager will prepare and submit a corrective action report to the Tetra Tech analytical coordinator. This report will identify the out-of-control situation and the steps that the laboratory has taken to rectify it.

## **3.2 REPORTS TO MANAGEMENT**

Effective management of environmental data collection requires (1) timely assessment and review of all activities and (2) open communication, interaction, and feedback among all project participants. Tetra Tech will use the reports described in the following text to address any project-specific quality issues and to facilitate timely communication of these issues.

### **3.2.1 Daily Progress Reports**

Tetra Tech will prepare a daily progress report to summarize activities throughout the field investigation. This report will describe sampling and field measurements, equipment used, Tetra Tech and subcontractor personnel on site, QA/QC and health and safety activities, problems encountered, corrective actions taken, deviations from the SAP, and explanations for the deviations. The daily progress report is prepared by the field team leader and submitted to the project manager and to the Navy remedial project manager (RPM), if requested. The content of the daily reports will be summarized and included in the final report submitted for the field investigation.

### **3.2.2 Project Monthly Status Report**

The Tetra Tech project manager will prepare a monthly status report (MSR) to be submitted to the Tetra Tech's program manager and the Navy RPM. Monthly status reports address project-specific quality issues and facilitate their timely communication. The MSR will include the following quality-related information:

- Project status
- Instrument, equipment, or procedural problems that affect quality and recommended solutions
- Objectives from the previous report that were achieved
- Objectives from the previous report that were not achieved
- Work planned for the next month

If appropriate, Tetra Tech will obtain similar information from subcontractors who are participating in the project and will incorporate the information within the MSR.

### **3.2.3 Quality Control Summary Report**

Tetra Tech will prepare a QCSR to be submitted to the Navy RPM with the final report for the field investigation. The QCSR will include a summary and evaluation of QA/QC activities, including any field or laboratory assessments, completed during the investigation. The QCSR will also indicate the location and duration of storage for the complete data packages. Particular emphasis will be placed on determining whether project DQOs were met and whether data are of adequate quality to support required decisions.

## **4.0 DATA VALIDATION AND USABILITY**

This section describes the procedures that are planned to review, verify, and validate field and laboratory data. This section also discusses procedures for verifying that the data are sufficient to meet DQOs and MQOs for the project.

### **4.1 DATA REVIEW, VERIFICATION, AND VALIDATION**

Validation and verification of the data generated during field and laboratory activities are essential to obtaining defensible data of acceptable quality. Verification and validation methods for field and laboratory activities are presented below.

#### **4.1.1 Field Data Verification**

Project team personnel will verify field data through reviews of data sets to identify inconsistencies or anomalous values. Any inconsistencies discovered will be resolved as soon as possible by seeking clarification from field personnel responsible for data collection. All field personnel will be responsible for following the sampling and documentation procedures described in this SAP so that defensible and justifiable data are obtained.

Data values that are significantly different from the population are called “outliers.” A systematic effort will be made to identify any outliers or errors before field personnel report the data. Outliers can result from improper sampling or measurement methodology, data transcription errors, calculation errors, or natural causes. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in sampling, measurement, transcription, or calculation will be clearly identified in project reports.

#### **4.1.2 Laboratory Data Verification**

Laboratory personnel will verify analytical data at the time of analysis and reporting and through subsequent reviews of the raw data for any nonconformances to the requirements of the analytical method. Laboratory personnel will make a systematic effort to identify any outliers or errors before they report the data. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in analysis, transcription, or calculation will be clearly identified in the case narrative section of the analytical data package.

#### **4.1.3 Laboratory Data Validation**

An independent third-party contractor will validate all laboratory data in accordance with current EPA national functional guidelines ([EPA 1994, 1999b](#)). The data validation strategy will be consistent with Navy guidelines. For this project, 90 percent of the data for contaminants of concern will undergo cursory validation, and 10 percent of the data for contaminants of concern will undergo full validation. Requirements for cursory and full validation are listed in the following text.

##### **4.1.3.1 Cursory Data Validation**

Cursory validation will be completed on 90 percent of the summary data packages for analysis of contaminants of concern. The data reviewer is required to notify Tetra Tech and request any missing information needed from the laboratory. Elimination of the data from the review process is not allowed. All data will be qualified as necessary in accordance with established criteria. Data summary packages will consist of sample results and QC summaries, including calibration and internal standard data.

#### **4.1.3.2 Full Data Validation**

Full validation will be completed on 10 percent of the full data packages for analysis of contaminants of concern. The data reviewer is required to notify Tetra Tech and request any missing information needed from the laboratory. Elimination of data from the review process is not allowed. All data will continue through the validation process and will be qualified in accordance with established criteria. Data summary packages will consist of sample results, QC summaries, and all raw data associated with the sample results and QC summaries.

#### **4.1.3.3 Data Validation Criteria**

[Table 11](#) lists the QC criteria that will be reviewed for both cursory and full data validation. The data validation criteria selected from [Table 11](#) will be consistent with the project-specific analytical methods referenced in [Section 2.4](#) of the SAP.

### **4.2 RECONCILIATION WITH USER REQUIREMENTS**

After environmental data have been reviewed, verified, and validated in accordance with the procedures described in [Section 4.1](#), the data must be further evaluated to determine whether DQOs have been met.

To the extent possible, Tetra Tech will follow EPA's data quality assessment (DQA) process to verify that the type, quality, and quantity of data collected are appropriate for their intended use. DQA methods and procedures are outlined in EPA's "Guidance for Data Quality Assessment, Practical Methods for Data Analysis" ([EPA 2000c](#)). The DQA process includes five steps: (1) review the DQOs and sampling design, (2) conduct a preliminary data review, (3) select a statistical test, (4) verify the assumptions of the statistical test, and (5) draw conclusions from the data.

When the five-step DQA process is not completely followed because the DQOs are qualitative, Tetra Tech will systematically assess data quality and data usability. This assessment will include the following:

- A review of the sampling design and sampling methods to verify that these were implemented as planned and are adequate to support project objectives
- A review of project-specific data quality indicators for PARCC criteria and quantitation limits (defined in [Section 1.3.2](#)) to determine whether acceptance criteria have been met
- A review of project-specific DQOs to determine whether they have been achieved by the data collected



- An evaluation of any limitations associated with the decisions to be made based on the data collected. For example, if data completeness is only 90 percent compared to a project-specific completeness objective of 95 percent, the data may still be usable to support a decision, but at a lower level of confidence

The final report for the project will discuss any potential impacts of these reviews on data usability and will clearly define any limitations associated with the data.

**TABLE 11: DATA VALIDATION CRITERIA**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

<b>Analytical Parameter Group</b>	<b>Cursory Data Validation Criteria</b>	<b>Full Data Validation Criteria</b>
Non-CLP Organic Analyses	Method compliance Holding times Calibration Blanks Surrogate recovery Matrix spike and matrix spike duplicate recovery Laboratory control sample or blank spike Internal standard performance Field duplicate sample analysis Other laboratory QC specified by the method Overall assessment of data for an SDG	Method compliance Holding times Calibration Blanks Surrogate recovery Matrix spike and matrix spike duplicate recovery Laboratory control sample or blank spike Internal standard performance Compound identification Detection limits Compound quantitation Sample results verification Other laboratory QC specified by the method Overall assessment of data for an SDG
Non-CLP Inorganic Analyses	Method compliance Holding times Calibration Blanks Matrix spike and matrix spike duplicate recovery Laboratory control sample or blank spike Field duplicate sample analysis Other laboratory QC specified by the method Overall assessment of data for an SDG	Method compliance Holding times Calibration Blanks Matrix spike and matrix spike duplicate recovery Laboratory control sample Field duplicate sample analysis Other laboratory QC specified by the method Detection limits Analyte identification Analyte quantitation Sample results verification Overall assessment of data for an SDG

Notes:

CLP      Contract Laboratory Program  
QC        Quality control  
SDG      Sample delivery group

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**APPENDIX A**  
**METHOD PRECISION AND ACCURACY GOALS**

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# TABLE A-1: PAHS, EPA METHOD 8270C, SW-846 PRECISION AND ACCURACY GOALS

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

## Laboratory and Matrix Spike Limits

Matrix Spike Compound	Water		Soil	
	% Recovery	RPD	% Recovery	RPD
Naphthalene	50-150	50	50-150	50
2-Methylnaphthalene	50-150	50	50-150	50
Acenaphthylene	50-150	50	50-150	50
Acenaphthene	50-150	50	50-150	50
Fluorene	50-150	50	50-150	50
Phenanthrene	50-150	50	50-150	50
Anthracene	50-150	50	50-150	50
Fluoranthene	50-150	50	50-150	50
Pyrene	50-150	50	50-150	50
Benzo(a)anthracene	50-150	50	50-150	50
Chrysene	50-150	50	50-150	50
Benzo(b)fluoranthene	50-150	50	50-150	50
Benzo(k)fluoranthene	50-150	50	50-150	50
Benzo(a)pyrene	50-150	50	50-150	50
Indeno(1,2,3-cd)pyrene	50-150	50	50-150	50
Dibenzo(a,h)anthracene	50-150	50	50-150	50
Benzo(g,h,i)perylene	50-150	50	50-150	50

## Surrogate Control Limits

Surrogate Compound	Water % Recovery	Soil % Recovery
2-Fluorophenol	60-140	60-140
Phenol-d <sub>6</sub>	60-140	60-140
Nitrobenzene-d <sub>8</sub>	60-140	60-140
2-Fluorobiphenyl	60-140	60-140
2,4,6-Tribromophenol	60-140	60-140
Terphenyl-d <sub>14</sub>	60-140	60-140

### Notes:

DGI	Data gaps investigation
EPA	U.S. Environmental Protection Agency
PAH	Polynuclear aromatic hydrocarbon
RPD	Relative percent difference
SAP	Sampling and analysis plan

**TABLE A-2: VOCs, METHOD 8260, SW-846, PRECISION AND ACCURACY GOALS**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

**Laboratory and Matrix Spike Limits**

Matrix Spike Compound	Water		Soil	
	% Recovery	RPD	% Recovery	RPD
1,1-Dichloroethene	61-145	14	59-172	22
Trichloroethene	71-120	14	62-137	24
Benzene	76-127	11	66-142	21
Toluene	76-125	13	59-139	21
Chlorobenzene	75-130	13	60-133	21

**Surrogate Control Limits**

Surrogate Compound	Water % Recovery	Soil % Recovery
Toluene-d <sub>8</sub>	88-110	84-138
Bromofluorobenzene	86-115	59-113
1,2-dichloroethane-d <sub>4</sub>	76-114	70-121

Note:

DGI     Data gaps investigation  
RPD     Relative percent difference  
SAP     Sampling and analysis plan  
VOC     Volatile organic compound



# **TABLE A-3: SVOCs, EPA METHOD 8270C, SW-846 PRECISION AND ACCURACY GOALS**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

## **Laboratory and Matrix Spike Limits**

Matrix Spike Compound	Water		Soil	
	% Recovery	RPD	% Recovery	RPD
Acenaphthene (B/N)	46-118	31	31-137	19
2,4-Dinitrotoluene (B/N)	24-96	38	28-89	47
Pyrene (B/N)	26-127	31	35-142	36
N-Nitroso-di-n-propylamine (B/N)	41-116	38	41-126	38
Pentachlorophenol (A)	9-103	50	17-109	47
Phenol (A)	12-110	42	26-90	35
2-Chlorophenol (A)	27-123	40	25-102	50
4-Chloro-3-methylphenol (A)	23-97	42	26-103	33
4-Nitrophenol (A)	10-80	50	11-114	50

## **Surrogate Control Limits**

Surrogate Compound	Water % Recovery	Soil % Recovery
Nitrobenzene-d <sub>5</sub> (B/N)	35-114	23-120
2-Fluorobiphenyl (B/N)	43-116	30-115
p-Terphenyl-d <sub>14</sub> (B/N)	33-141	18-137
1,2-Dichlorobenzene-d <sub>4</sub> (B/N)	16-110	20-130
Phenol-d <sub>5</sub> (A)	10-110	24-113
2-Fluorophenol (A)	21-110	25-121
2,4,6-Tribromophenol (A)	10-123	19-122
2-Chlorophenol-d <sub>4</sub> (A)	33-110	20-130

### Notes:

A      Acid  
B/N     Base/Neutral  
DGI     Data gaps investigation  
EPA     U.S. Environmental Protection Agency  
RPD     Relative percent difference  
SAP     Sampling and analysis plan  
SVOC   Semivolatile organic compound

**TABLE A-4: OTHER ANALYSES METHOD PRECISION AND ACCURACY GOALS**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and  
the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

Inorganic Analyses	Water		Soil	
	% Recovery <sup>a</sup>	RPD <sup>b</sup>	% Recovery <sup>a</sup>	RPD <sup>b</sup>
Metals – EPA 6010B, SW-846	75-125	20	75-125	35
Hexavalent Chromium – EPA 7196A, SW-846	75-125	20	75-125	35

Organic Analyses	Laboratory/Matrix Spike		Surrogates
	% Recovery <sup>c</sup>	RPD	% Recovery <sup>c</sup>
TPHP – EPA 8015, SW-846	70-130	30	75-125
TPHE – EPA 8015, SW-846	50-150	50	60-140

Notes:

- a Percent recovery control limit is based on spiked sample
- b Relative percent difference control limit is based on duplicate sample
- c Percent recovery control limit for both water and soil samples

DGI Data gaps investigation  
EPA U.S. Environmental Protection Agency  
RPD Relative percent difference  
SAP Sampling and analysis plan  
TPHP Total petroleum hydrocarbons-purgeables  
TPHE Total petroleum hydrocarbons-extractables

## **APPENDIX B**

### **STANDARD OPERATING PROCEDURES**

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**SOP APPROVAL FORM**

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

**GENERAL EQUIPMENT DECONTAMINATION**

**SOP NO. 002**

**REVISION NO. 2**

Last Reviewed: December 1999



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Quality Assurance Approved

*February 2, 1993*

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Date

## **1.0 BACKGROUND**

All nondisposable field equipment must be decontaminated before and after each use at each sampling location to obtain representative samples and to reduce the possibility of cross-contamination.

### **1.1 PURPOSE**

This standard operating procedure (SOP) establishes the requirements and procedures for decontaminating equipment in the field.

### **1.2 SCOPE**

This SOP applies to decontaminating general nondisposable field equipment. To prevent contamination of samples, all sampling equipment must be thoroughly cleaned prior to each use.

### **1.3 DEFINITIONS**

**Alconox:** Nonphosphate soap

### **1.4 REFERENCES**

U.S. Environmental Protection Agency (EPA). 1992. "RCRA Ground-Water Monitoring: Draft Technical Guidance. Office of Solid Waste. Washington, DC. EPA/530-R-93-001. November.

EPA. 1994. "Sampling Equipment Decontamination." Environmental Response Team SOP #2006 (Rev. #0.0, 08/11/94). On-Line Address: [http://204.46.140.12/media\\_resrcs/media\\_resrcs.asp?Child1=](http://204.46.140.12/media_resrcs/media_resrcs.asp?Child1=)

### **1.5 REQUIREMENTS AND RESOURCES**

The equipment required to conduct decontamination is as follows:

- Scrub brushes
- Large wash tubs or buckets
- Squirt bottles

- Alconox
- Tap water
- Distilled water
- Plastic sheeting
- Aluminum foil
- Methanol or hexane
- Dilute (0.1 N) nitric acid

## **2.0 PROCEDURE**

The procedures below discuss decontamination of personal protective equipment (PPE), drilling and monitoring well installation equipment, borehole soil sampling equipment, water level measurement equipment, and general sampling equipment.

### **2.1 PERSONAL PROTECTIVE EQUIPMENT DECONTAMINATION**

Personnel working in the field are required to follow specific procedures for decontamination prior to leaving the work area so that contamination is not spread off-site or to clean areas. All used disposable protective clothing, such as Tyvek coveralls, gloves, and booties, will be containerized for later disposal. Decontamination water will be containerized in 55-gallon drums.

Personnel decontamination procedures will be as follows:

1. Wash neoprene boots (or neoprene boots with disposable booties) with Liquinox or Alconox solution and rinse with clean water. Remove booties and retain boots for subsequent reuse.
2. Wash outer gloves in Liquinox or Alconox solution and rinse in clean water. Remove outer gloves and place into plastic bag for disposal.
3. Remove Tyvek or coveralls. Containerize Tyvek for disposal and place coveralls in plastic bag for reuse.
4. Remove air purifying respirator (APR), if used, and place the spent filters into a plastic bag for disposal. Filters should be changed daily or sooner depending on use and application. Place respirator into a separate plastic bag after cleaning and disinfecting.
5. Remove disposable gloves and place them in plastic bag for disposal.

6. Thoroughly wash hands and face in clean water and soap.

## **2.2 DRILLING AND MONITORING WELL INSTALLATION EQUIPMENT DECONTAMINATION**

All drilling equipment should be decontaminated at a designated location on-site before drilling operations begin, between borings, and at completion of the project.

Monitoring well casing, screens, and fittings are assumed to be delivered to the site in a clean condition. However, they should be steam cleaned on-site prior to placement downhole. The drilling subcontractor will typically furnish the steam cleaner and water.

After cleaning the drilling equipment, field personnel should place the drilling equipment, well casing and screens, and any other equipment that will go into the hole on clean polyethylene sheeting.

The drilling auger, bits, drill pipe, temporary casing, surface casing, and other equipment should be decontaminated by the drilling subcontractor by hosing down with a steam cleaner until thoroughly clean. Drill bits and tools that still exhibit particles of soil after the first washing should be scrubbed with a wire brush and then rinsed again with a high-pressure steam rinse.

All wastewater from decontamination procedures should be containerized.

## **2.3 BOREHOLE SOIL SAMPLING EQUIPMENT DECONTAMINATION**

The soil sampling equipment should be decontaminated after each sample as follows:

1. Prior to sampling, scrub the split-barrel sampler and sampling tools in a bucket using a stiff, long bristle brush and Liquinox or Alconox solution.
2. Steam clean the sampling equipment over the rinsate tub and allow to air dry.
3. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
4. Containerize all water and rinsate.

5. Decontaminate all pipe placed down the hole as described for drilling equipment.

## **2.4 WATER LEVEL MEASUREMENT EQUIPMENT DECONTAMINATION**

Field personnel should decontaminate the well sounder and interface probe before inserting and after removing them from each well. The following decontamination procedures should be used:

1. Wipe the sounding cable with a disposable soap-impregnated cloth or paper towel.
2. Rinse with deionized organic-free water.

## **2.5 GENERAL SAMPLING EQUIPMENT DECONTAMINATION**

All nondisposable sampling equipment should be decontaminated using the following procedures:

1. Select an area removed from sampling locations that is both downwind and downgradient. Decontamination must not cause cross-contamination between sampling points.
2. Maintain the same level of protection as was used for sampling.
3. To decontaminate a piece of equipment, use an Alconox wash; a tap water wash; a solvent (methanol or hexane) rinse, if applicable or dilute (0.1 N) nitric acid rinse, if applicable; a distilled water rinse; and air drying. Use a solvent (methanol or hexane) rinse for grossly contaminated equipment (for example, equipment that is not readily cleaned by the Alconox wash). The dilute nitric acid rinse may be used if metals are the analyte of concern.
4. Place cleaned equipment in a clean area on plastic sheeting and wrap with aluminum foil.
5. Containerize all water and rinsate.



**SOP APPROVAL FORM**

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

**PACKAGING AND SHIPPING SAMPLES**

**SOP NO. 019**

**REVISION NO. 5**

Last Reviewed: January 2000



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Quality Assurance Approved

*January 28, 2000*

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Date

## **1.0 BACKGROUND**

In any sampling program, the integrity of a sample must be ensured from its point of collection to its final disposition. Procedures for classifying, packaging, and shipping samples are described below. Steps in the procedures should be followed to ensure sample integrity and to protect the welfare of persons involved in shipping and receiving samples. When hazardous substances and dangerous goods are sent by common carrier, their packaging, labeling, and shipping are regulated by the U.S. Department of Transportation (DOT) Hazardous Materials Regulations (HMR, *Code of Federal Regulations*, Title 49 [49 CFR] Parts 106 through 180) and the International Air Transportation Association (IATA) Dangerous Goods Regulations (DGR).

### **1.1 PURPOSE**

This standard operating procedure (SOP) establishes the requirements and procedures for packaging and shipping samples. It has been prepared in accordance with the U.S. Environmental Protection Agency (EPA) “Sampler’s Guide to the Contract Laboratory Program (CLP),” the DGR, and the HMR. Sample packaging and shipping procedures described in this SOP should be followed for all sample packaging and shipping. Deviations from the procedures in this SOP must be documented in a field logbook. This SOP assumes that samples are already collected in the appropriate sample jars and that the sample jars are labeled and tagged appropriately.

### **1.2 SCOPE**

This SOP applies to sample classification, packaging, and shipping.

### **1.3 DEFINITIONS**

**Custody seal:** A custody seal is a tape-like seal. Placement of the custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been packaged for shipping.

**Dangerous goods:** Dangerous goods are articles or substances that can pose a significant risk to health, safety, or property when transported by air; they are classified as defined in Section 3 of the DGR (IATA 1999).

**Environmental samples:** Environmental samples include drinking water, most groundwater and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, and biological specimens. Environmental samples typically contain low concentrations of contaminants and when handled require only limited precautionary procedures.

**Hazardous Materials Regulations:** The HMR are DOT regulations for the shipment of hazardous materials by air, water, and land; they are located in 49 CFR 106 through 180.

**Hazardous samples:** Hazardous samples include dangerous goods and hazardous substances. Hazardous samples shipped by air should be packaged and labeled in accordance with procedures specified by the DGR; ground shipments should be packaged and labeled in accordance with the HMR.

**Hazardous substance:** A hazardous substance is any material, including its mixtures and solutions, that is listed in Appendix A of 49 CFR 172.101 and its quantity, in one package, equals or exceeds the reportable quantity (RQ) listed in the appendix.

**IATA Dangerous Goods Regulations:** The DGR are regulations that govern the international transport of dangerous goods by air. The DGR are based on the International Civil Aviation Organization (ICAO) Technical Instructions. The DGR contain all of the requirements of the ICAO Technical Instructions and are more restrictive in some instances.

**Nonhazardous samples:** Nonhazardous samples are those samples that do not meet the definition of a hazardous sample and **do not** need to be packaged and shipped in accordance with the DGR or HMR.

**Overpack:** An enclosure used by a single shipper to contain one or more packages and to form one handling unit (IATA 1999). For example, a cardboard box may be used to contain three fiberboard boxes to make handling easier and to save on shipping costs.

## 1.4 REFERENCES

U.S. Department of Transportation, Transport Canada, and the Secretariat of Communications and Transportation of Mexico (DOT and others). 1996. "1996 North American Emergency Response Guidebook."

International Air Transport Association (IATA). 1997. "Guidelines for Instructors of Dangerous Courses."

IATA. 1999. "Dangerous Goods Regulations." 40th Edition.

U.S. Environmental Protection Agency. 1996. "Sampler's Guide to the Contract Laboratory Program." Office of Solid Waste and Emergency Response. Washington, DC. EPA/540/R-96/032. On-Line Address: <http://www.epa.gov/oerrpage/superfund/programs/clp/guidance.htm#sample>

## 1.5 REQUIREMENTS AND RESOURCES

The procedures for packaging and shipping **nonhazardous** samples require the following:

- Coolers
- Ice
- Vermiculite, bubble wrap, or similar cushioning material
- Chain-of-custody forms and seals
- Airbills
- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)

The procedures for packaging and shipping **hazardous** samples require the following:

- Ice
- Vermiculite or other non-combustible, absorbent packing material
- Chain-of-custody forms and seals
- Appropriate dangerous goods airbills and emergency response information to attach to the airbill

- Resealable plastic bags for sample jars and ice
- Tape (strapping and clear)
- Appropriate shipping containers as specified in the DGR
- Labels that apply to the shipment such as hazard labels, address labels, “Cargo Aircraft Only” labels, and package orientation labels (up arrows)

## **2.0 PROCEDURES**

The following procedures apply to packaging and shipping nonhazardous and hazardous samples.

### **2.1 SAMPLE CLASSIFICATION**

Prior to sample shipment, it must be determined whether the sample is subject to the DGR. Samples subject to these regulations shall be referred to as hazardous samples. If the hazardous sample is to be shipped by air, then the DGR should be followed. Any airline, including FedEx, belonging to IATA must follow the DGR. As a result, FedEx **may not** accept a shipment that is packaged and labeled in accordance with the HMR (although in most cases, the packaging and labeling would be the same for either set of regulations). The HMR states that a hazardous material may be transported by aircraft in accordance with the ICAO Technical Instruction (49 CFR 171.11) upon which the DGR is based. Therefore, the use of the DGR for samples to be shipped by air complies with the HMR, but not vice versa.

Most environmental samples are not hazardous samples and do not need to be packaged in accordance with any regulations. Hazardous samples are those samples that can be classified as specified in Section 3 of the DGR, can be found in the List of Dangerous Goods in the DGR in bold type, are considered a hazardous substance (see definition), or are mentioned in “Section 2 - Limitations” of the DGR for countries of transport or airlines (such as FedEx). The hazard classifications specified in the DGR (and the HMR) are as follows:

Class 1 - Explosives

Division 1.1 - Articles and substances having a mass explosion hazard

- Division 1.2 - Articles and substances having a projection hazard but not a mass explosion hazard
- Division 1.3 - Articles and substances having a fire hazard, a minor blast hazard and/or a minor projection hazard but not a mass explosion hazard
- Division 1.4 - Articles and substances presenting no significant hazard
- Division 1.5 - Very sensitive substances mass explosion hazard
- Division 1.6 - Extremely insensitive articles which do not have a mass explosion hazard

## Class 2 - Gases

- Division 2.1 - Flammable gas
- Division 2.2 - Non-flammable, non-toxic gas
- Division 2.3 - Toxic gas

## Class 3 - Flammable Liquids

## Class 4 - Flammable Solids; Substances Liable to Spontaneous Combustion; Substances, which, in Contact with Water, Emit Flammable Gases

- Division 4.1 - Flammable solids.
- Division 4.2 - Substances liable to spontaneous combustion.
- Division 4.3 - Substances, which, in contact with water, emit flammable gases.

## Class 5 - Oxidizing Substances and Organic Peroxide

- Division 5.1 - Oxidizers.
- Division 5.2 - Organic peroxides.

## Class 6 - Toxic and Infectious Substances

- Division 6.1 - Toxic substances.
- Division 6.2 - Infectious substances.

## Class 7 - Radioactive Material

## Class 8 - Corrosives

## Class 9 - Miscellaneous Dangerous Goods

The criteria for each of the first eight classes are very specific and are outlined in Section 3 of the DGR and 49 CFR 173 of the HMR. Some classes and divisions are further divided into packing groups based on their level of danger. Packing group I indicates a great danger, packing group II indicates a medium danger, and packing group III indicates a minor danger. Class 2, gases, includes any compressed gas being

shipped and any noncompressed gas that is either flammable or toxic. A compressed gas is defined as having a pressure over 40 pounds per square inch (psi) absolute (25 psi gauge). Most air samples and empty cylinders that did not contain a flammable or toxic gas are exempt from the regulations. An empty hydrogen cylinder, as in a flame ionization detector (FID), is considered a dangerous good unless it is properly purged with nitrogen in accordance with the HMR. A landfill gas sample is usually considered a flammable gas because it may contain a high percentage of methane. Class 3, flammable liquids, are based on the boiling point and flash point of a substance. Most class 3 samples include solvents, oil, gas, or paint-related material collected from drums, tanks, or pits. Division 6.1, toxic substances, is based on oral toxicity (LD<sub>50</sub> [lethal dose that kills 50 percent of the test animals]), dermal toxicity (LD<sub>50</sub> values), and inhalation toxicity (LC<sub>50</sub> [lethal concentration that kills 50 percent of the test animals] values).

Division 6.1 substances include pesticides and cyanide. Class 7, radioactive material, is defined as any article or substance with a specific activity greater than 70 kiloBecquerels (kBq/kg) (0.002 [microCuries per gram [μCi/g]). If the specific activity exceeds this level, the sample should be shipped in accordance with Section 10 of the DGR. Class 8, corrosives, are based on the rate at which a substance destroys skin tissue or corrodes steel; they are not based on pH. Class 8 materials include the concentrated acids used to preserve water samples. Preserved water samples are not considered class 8 substances and should be packaged as nonhazardous samples. Class 9, miscellaneous dangerous goods, are substances that present a danger but are not covered by any other hazard class. Examples of class 9 substances include asbestos, polychlorinated biphenyls (PCB), and dry ice.

Unlike the DGR, the HMR includes combustible liquids in hazard class 3. The definition of a combustible liquid is specified in 49 CFR 173.120 of the HMR. The HMR has an additional class, ORM-D, that is not specified in the DGR. “ORM-D material” refers to a material such as a consumer commodity, that although otherwise subject to the HMR, presents a limited hazard during transport due to its form, quantity, and packaging. It must be a material for which exceptions are provided in the table of 49 CFR 172.101. The DGR lists consumer commodities as a class 9 material.

In most instances, the hazard of a material sampled is unknown because no laboratory testing has been conducted. A determination as to the suspected hazard of the sample must be made using knowledge of the site, field observations, field tests, and other available information.

According to 40 CFR 261.4(d) and (e), samples transported to a laboratory for testing or treatability studies, including samples of hazardous wastes, are **not** hazardous wastes. FedEx will not accept a shipment of hazardous waste.

## **2.2 PACKAGING NONHAZARDOUS SAMPLES**

Nonhazardous samples, after being appropriately containerized, labeled, and tagged, should be packaged in the following manner. Note that these are general instructions; samplers should be aware of any client-specific requirements concerning the placement of custody seals or other packaging provisions.

1. Place the sample in a resealable plastic bag.
2. Place the bagged sample in a cooler and pack it to prevent breakage.
3. Prevent breakage of bottles during shipment by either wrapping the sample container in bubble wrap, or lining the cooler with a noncombustible material such as vermiculite. Vermiculite is especially recommended because it will absorb any free liquids inside the cooler. It is recommended that the cooler be lined with a large plastic garbage bag before samples, ice, and absorbent packing material are placed in the cooler.
4. Add a sufficient quantity of ice to the cooler to cool samples to 4 °C. Ice should be double bagged in resealable plastic bags to prevent the melted ice from leaking out. As an option, a temperature blank (a sample bottle filled with distilled water) can be included with the cooler.
5. Seal the completed chain-of-custody forms in a plastic bag and tape the plastic bag to the inside of the cooler lid.
6. Tape any instructions for returning the cooler to the inside of the lid.
7. Close the lid of the cooler and tape it shut by wrapping strapping tape around both ends and hinges of the cooler at least once. Tape shut any drain plugs on the cooler.
8. Place two signed custody seals on the cooler, ensuring that each one covers the cooler lid and side of the cooler. Place clear plastic tape over the custody seals.
9. Place address labels on the outside of the cooler.
10. Ship samples overnight by a commercial carrier such as FedEx.



## **2.3 PACKAGING HAZARDOUS SAMPLES**

The procedures for packaging hazardous samples are summarized below. Note that according to the DGR, all spellings must be exactly as they appear in the List of Dangerous Goods, and only approved abbreviations are acceptable. The corresponding HMR regulations are provided in parentheses following any DGR referrals. The HMR must be followed only if shipping hazardous samples by ground transport.

1. Determine the proper shipping name for the material to be shipped. All proper shipping names are listed in column B of the List of Dangerous Goods table in Section 4 of the DGR (or column 2 of the Hazardous Materials Table in 49 CFR 172.101). In most instances, a generic name based on the hazard class of the material is appropriate. For example, a sample of an oily liquid collected from a drum with a high photoionization detector (PID) reading should be packaged as a flammable liquid. The proper shipping name chosen for this sample would be “flammable liquid, n.o.s.” The abbreviation “n.o.s.” stands for “not otherwise specified” and is used for generic shipping names. Typically, a specific name, such as acetone, should be inserted in parentheses after most n.o.s. descriptions. However, a technical name is not required when shipping a sample for testing purposes and the components are not known. If shipping a hazardous substance (see definition), then the letters “RQ” must appear in front of the proper shipping name.
2. Determine the United Nations (UN) identification number, class or division, subsidiary risk if any, required hazard labels, packing group, and either passenger aircraft or cargo aircraft packing instructions based on the quantity of material being shipped in one package. This information is provided in the List of Dangerous Goods (or Hazardous Materials Table in 49 CFR 172.101) under the appropriate proper shipping name. A “Y” in front of a packing instruction indicates a limited quantity packing instruction. If shipping dry ice or a limited quantity of a material, then UN specification shipping containers do not need to be used.
3. Determine the proper packaging required for shipping the samples. Except for limited quantity shipments and dry ice, these are UN specification packages that have been tested to meet the packing group of the material being shipped. Specific testing requirements of the packages is listed in Section 6 of the DGR (or 49 CFR 178 of the HMR). All UN packages are stamped with the appropriate UN specification marking. Prior planning is required to have the appropriate packages on hand during a sampling event where hazardous samples are anticipated. Most samples can be shipped in either a 4G fiberboard box, a 1A2 steel drum, or a 1H2 plastic drum. Drums can be purchased in 5- and 20-gallon sizes and are ideal for shipping multiple hazardous samples. When FedEx is used to ship samples containing PCBs, the samples must be shipped in an inner metal packaging (paint can) inside a 1A2 outer steel drum. This method of packaging PCB samples is in accordance with FedEx variation FX-06, listed in Section 2 of the DGR.

4. Place each sample jar in a separate resealable plastic bag. Some UN specification packagings contain the sample jar and plastic bag to be used when shipping the sample.
5. Place each sealed bag inside the approved UN specification container (or other appropriate container if a limited quantity or dry ice) and pack with enough noncombustible, absorbent, cushioning material (such as vermiculite) to prevent breakage and to absorb liquid.
6. Place chain-of-custody forms in a resealable plastic bag and either attach it to the inside lid of the container or place it on top inside the container. Place instructions for returning the container to the shipper on the inside lid of the container as appropriate. Close and seal the shipping container in the manner appropriate for the type of container being used.
7. Label and mark each package appropriately. All irrelevant markings and labels need to be removed or obliterated. All outer packagings must be marked with proper shipping name, UN identification number, and name and address of the shipper and the recipient. For carbon dioxide, solid (dry ice), the net weight of the dry ice within the package needs to be marked on the outer package. For limited quantity shipments, the words “limited quantity” or “LTD. QTY.” must be marked on the outer package. Affix the appropriate hazard label to the outer package. If the material being shipped contains a subsidiary hazard, then a subsidiary hazard label must also be affixed to the outer package. The subsidiary hazard label is identical to the primary hazard label except that the class or division number is not present. It is acceptable to obliterate the class or division marking on a primary hazard label and use it as the subsidiary hazard label. If using cargo aircraft only packing instructions, then the “Cargo Aircraft Only” label must be used. Package orientation labels (up arrows) must be placed on opposite sides of the outer package. Figure 1 depicts a properly marked and labeled package.
8. If using an overpack (see definition), mark and label the overpack and each outer packaging within the overpack as described in step 7. In addition, the statement “INNER PACKAGES COMPLY WITH PRESCRIBED SPECIFICATIONS” must be marked on the overpack.
9. Attach custody seals, and fill out the appropriate shipping papers as described in Section 2.4.

## **2.4 SHIPPING PAPERS FOR HAZARDOUS SAMPLES**

A “Shippers Declaration for Dangerous Goods” and “Air Waybill” must be completed for each shipment of hazardous samples. FedEx supplies a Dangerous Goods Airbill to its customers; the airbill combines both

the declaration and the waybill. An example of a completed Dangerous Goods Airbill is depicted in Figure

2. A shipper's declaration must contain the following:

- Name and address of shipper and recipient
- Air waybill number (not applicable to the HMR)
- Page \_\_\_\_ of \_\_\_\_
- Deletion of either "Passenger and Cargo Aircraft" or "Cargo Aircraft Only," whichever does not apply
- Airport or city of departure
- Airport or city of destination
- Deletion of either "Non-Radioactive" or "Radioactive," which ever does not apply
- The nature and quantity of dangerous goods. This includes the following information in the following order (obtained from the List of Dangerous Goods in the DGR): proper shipping name, class or division number, UN identification number, packing group number, subsidiary risk, quantity in liters or kilograms (kg), type of packaging used, packing instructions, authorizations, and additional handling information. Authorizations include the words "limited quantity" or "LTD. QTY." if shipping a limited quantity, any special provision numbers listed in the List of Dangerous Goods in the DGR, and the variation "USG-14" when a technical name is required after the proper shipping name but not entered because it is unknown.
- Signature for the certification statement
- Name and title of signatory
- Place and date of signing certification
- A 24-hour emergency response telephone number for use in the event of an incident involving the dangerous good
- Emergency response information attached to the shipper's declaration. This information can be in the form of a material safety data sheet or the applicable North American Emergency Response Guidebook (NAERG; DOT 1996) pages. Figure 3 depicts the appropriate NAERG emergency response information for "Flammable liquids, n.o.s." as an example.

Note that dry ice does not require an attached shipper's declaration. However, the air waybill must include the following on it: "Dry ice, 9, UN1845, \_\_\_\_ x \_\_\_\_ kg." The blanks must include the number of packages and the quantity in kg in each package. If using FedEx to ship dry ice, the air waybill includes a box specifically for dry ice. Simply check the appropriate box and enter in the number of packages and quantity in each package.

The HMR requirements for shipping papers are located in 49 CFR 172 Subpart C.

### **3.0 POTENTIAL PROBLEMS**

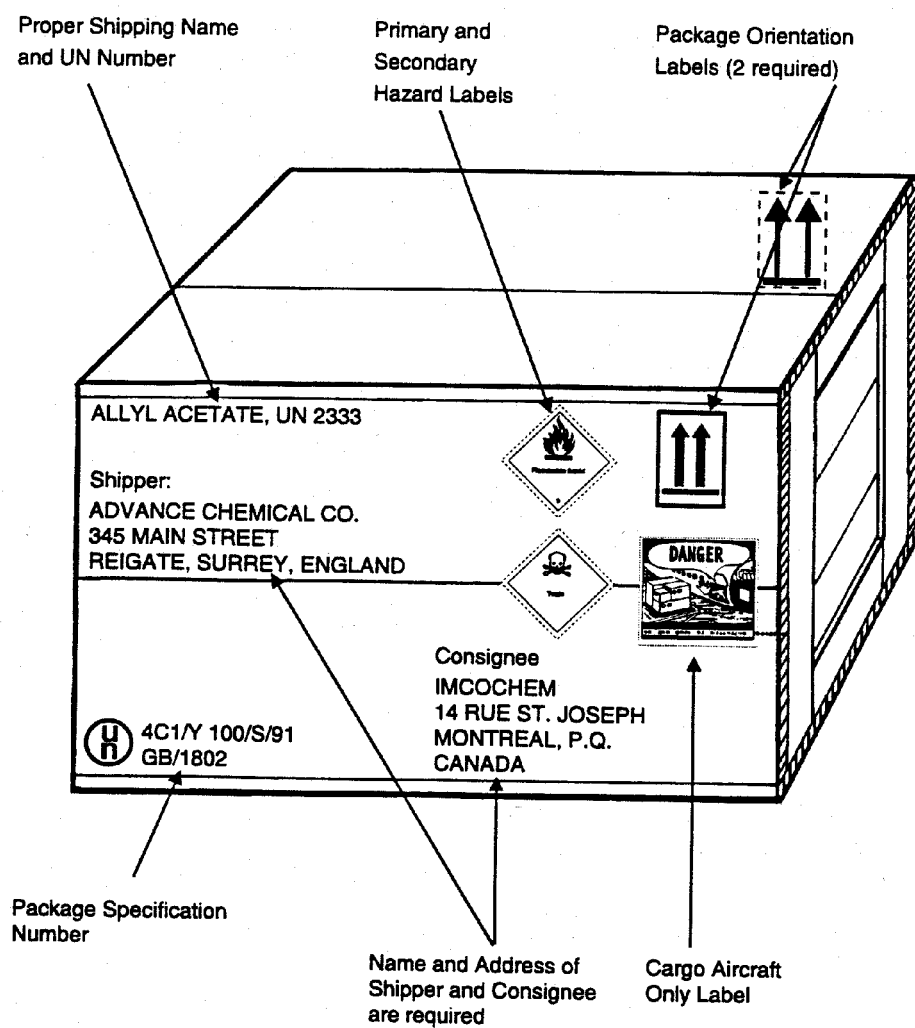
The following potential problems may occur during sample shipment:

- Leaking package. If a package leaks, the carrier may open the package, return the package, and if a dangerous good, inform the Federal Aviation Administration (FAA), which can result in fines.
- Improper labeling and marking of package. If mistakes are made in labeling and marking the package, the carrier will most likely notice the mistakes and return the package to the shipper, thus delaying sample shipment.
- Improper, misspelled, or missing information on the shipper's declaration. The carrier will most likely notice this as well and return the package to the shipper.

Contact FedEx with questions about dangerous goods shipments by calling 1-800-463-3339 and asking for a dangerous goods expert.

**FIGURE 1**

**EXAMPLE OF A CORRECTLY MARKED AND LABELED DANGEROUS GOODS PACKAGE**



Source: International Air Transport Association (IATA). 1997.

FIGURE 2

EXAMPLE OF A DANGEROUS GOODS AIRBILL

**FedEx** Dangerous Goods Airbill **Sender's Copy**  
11729489 **RETAIN THIS COPY FOR YOUR RECORDS**

**1 From** Please print and press hard.  
Date **FILL IN** Sender's FedEx Account Number **1788-8014-4**  
Sender's Name **FILL IN** Phone **(312) 856 8700**

Company **TETRA TECH EM INC**  
Address **200 E RANDOLPH ST STE 4700** Dept./Floor/Suite/Room  
City **CHICAGO** State **IL** ZIP **60601**

**2** Your Internal Billing Reference **FILL IN**  
**3 To**  
Recipient's Name **FILL IN** Phone **FILL IN**  
Company **FILL IN**  
Address **FILL IN** (To: H.O.D. at FedEx location, print FedEx address here) Dept./Floor/Suite/Room  
City **FILL IN** State **FILL IN** ZIP **FILL IN**

**4a Express Package Service** Packages up to 150 lbs.  
☒ FedEx Priority Overnight Next business morning  
☐ FedEx Standard Overnight Next business afternoon  
☐ FedEx 2Day Second business day  
☐ FedEx Express Saver Third business day

**4b Express Freight Service** Packages over 150 lbs.  
☐ FedEx 10Day Freight\* Next business day  
☐ FedEx 2Day Freight\* Second business day  
☐ FedEx 30Day Freight\* Third business day

**5 Packaging**  
☒ Other Packaging  
Dangerous Goods cannot be shipped in FedEx packaging.

**6 Special Handling**  
☒ Dangerous Goods as per attached Shipper's Declaration ☐ Cargo Aircraft Only

**7 Payment**  
Bill to: ☒ Sender ☐ Recipient ☐ Third Party ☐ Credit Card ☐ Cash Check  
FedEx Account No. **FILL IN**

**8 Signature Release Unavailable** PART 154927 • Rev. Date 1/98 ©1994-98 FedEx • PRINTED IN U.S.A.

**TRANSPORT DETAILS**  
This shipment is within the limitations prescribed for (delete non-applicable):  
☒ PASSENGER AND CARGO AIRCRAFT ☒ CARGO AIRCRAFT ONLY  
Airport of Departure: **Chicago**  
Airport of Destination: **"City sending sample to"**

**NATURE AND QUANTITY OF DANGEROUS GOODS**

Dangerous Goods Identification					Quantity and Type of Packaging	Packing Instr.	Authorization
Proper Shipping Name	Class or Division	UN or I.D. No.	Packing Group	Subsidiary Risk			
Flammable liquid, n.o.s.	3	UN 1993	III	—	4 glass jars in a 2A2 steel drum Net Quantity = 4L	309	A3 USG-14

**Additional Handling Information**  
**NAERG# 128 Attached.**

**Prepared for AIR TRANSPORT according to:**  
☐ 49 CFR ☒ ICAO / IATA

I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name and are classified, packaged, marked, and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

Emergency Telephone Number (Required for U.S. Origin or Destination Shipments) **FILL IN**

Name/Title of Signatory **ME, Environmental Scientist**  
Place and Date **200 E Randolph, Chicago, IL xx/xx/xx**  
Signature **me**

**IF ACCEPTABLE FOR PASSENGER AIRCRAFT, THIS SHIPMENT CONTAINS RADIOACTIVE MATERIAL INTENDED FOR USE IN, OR INCIDENT TO, RESEARCH, MEDICAL DIAGNOSIS, OR TREATMENT.**

**FIGURE 3**

**NAERG EMERGENCY RESPONSE INFORMATION  
FOR FLAMMABLE LIQUIDS, N.O.S.**

GUIDE 128	FLAMMABLE LIQUIDS (NON-POLAR/WATER-IMMISCIBLE)	NAERG96	NAERG96	FLAMMABLE LIQUIDS (NON-POLAR/WATER-IMMISCIBLE)	GUIDE 128
	<b>POTENTIAL HAZARDS</b>			<b>EMERGENCY RESPONSE</b>	
	<b>FIRE OR EXPLOSION</b> <ul style="list-style-type: none"><li>• <b>HIGHLY FLAMMABLE:</b> Will be easily ignited by heat, sparks or flames.</li><li>• Vapors may form explosive mixtures with air.</li><li>• Vapors may travel to source of ignition and flash back.</li><li>• Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks).</li><li>• Vapor explosion hazard indoors, outdoors or in sewers.</li><li>• Some may polymerize (P) explosively when heated or involved in a fire.</li><li>• Runoff to sewer may create fire or explosion hazard.</li><li>• Containers may explode when heated.</li><li>• Many liquids are lighter than water.</li><li>• Substance may be transported hot.</li></ul>		<b>FIRE</b> <p><b>CAUTION:</b> All these products have a very low flash point: Use of water spray when fighting fire may be inefficient.</p> <p><b>Small Fires</b></p> <ul style="list-style-type: none"><li>• Dry chemical, CO<sub>2</sub>, water spray or regular foam.</li></ul> <p><b>Large Fires</b></p> <ul style="list-style-type: none"><li>• Water spray, fog or regular foam.</li><li>• Do not use straight streams.</li><li>• Move containers from fire area if you can do it without risk.</li></ul> <p><b>Fire Involving Tanks or Car/Trailer Loads</b></p> <ul style="list-style-type: none"><li>• Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.</li><li>• Cool containers with flooding quantities of water until well after fire is out.</li><li>• Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.</li><li>• ALWAYS stay away from the ends of tanks.</li><li>• For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.</li></ul>		<b>SPILL OR LEAK</b> <ul style="list-style-type: none"><li>• ELIMINATE all ignition sources (no smoking, flames, sparks or flames in immediate area).</li><li>• All equipment used when handling the product must be grounded.</li><li>• Do not touch or walk through spilled material.</li><li>• Stop leak if you can do it without risk.</li><li>• Prevent entry into waterways, sewers, basements or confined areas.</li><li>• A vapor suppressing foam may be used to reduce vapors.</li><li>• Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.</li><li>• Use clean non-sparking tools to collect absorbed material.</li></ul> <p><b>Large Spills</b></p> <ul style="list-style-type: none"><li>• Dike for ahead of liquid spill for later disposal.</li><li>• Water spray may reduce vapor; but may not prevent ignition in closed spaces.</li></ul>
	<b>HEALTH</b> <ul style="list-style-type: none"><li>• Inhalation or contact with material may irritate or burn skin and eyes.</li><li>• Fire may produce irritating, corrosive and/or toxic gases.</li><li>• Vapors may cause dizziness or suffocation.</li><li>• Runoff from fire control or dilution water may cause pollution.</li></ul>		<b>FIRST AID</b> <ul style="list-style-type: none"><li>• Move victim to fresh air.</li><li>• Call emergency medical care.</li><li>• Apply artificial respiration if victim is not breathing.</li><li>• Administer oxygen if breathing is difficult.</li><li>• Remove and isolate contaminated clothing and shoes.</li><li>• In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes.</li><li>• Wash skin with soap and water.</li><li>• Keep victim warm and quiet.</li><li>• Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.</li></ul>		
	<b>PUBLIC SAFETY</b> <ul style="list-style-type: none"><li>• <b>CALL</b> Emergency Response Telephone Number on Shipping Paper first, if Shipping Paper not available or no answer, refer to appropriate telephone number listed on the inside back cover.</li><li>• Isolate spill or leak area immediately for at least 25 to 50 meters (80 to 160 feet) in all directions.</li><li>• Keep unauthorized personnel away.</li><li>• Stay upwind.</li><li>• Keep out of low areas.</li><li>• Ventilate closed spaces before entering.</li></ul>				
	<b>PROTECTIVE CLOTHING</b> <ul style="list-style-type: none"><li>• Wear positive pressure self-contained breathing apparatus (SCBA).</li><li>• Structural firefighters' protective clothing will only provide limited protection.</li></ul>				
	<b>EVACUATION</b> <p><b>Large Spill</b></p> <ul style="list-style-type: none"><li>• Consider initial downwind evacuation for at least 300 meters (1000 feet).</li></ul> <p><b>Fire</b></p> <ul style="list-style-type: none"><li>• If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.</li></ul>				

Source: DOT and others. 1996.

**SOP APPROVAL FORM**

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

**MONITORING WELL INSTALLATION**

**SOP NO. 020**

**REVISION NO. 3**

Last Reviewed: December 2000

*K. Miesing*

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Quality Assurance Approved

*December 19, 2000*

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Date



## 1.0 BACKGROUND

Groundwater monitoring wells are designed and installed for a variety of reasons including: (1) detecting the presence or absence of contaminants, (2) collecting groundwater samples representative of in situ aquifer chemical characteristics, or (3) measuring water levels for determining groundwater potentiometric head and groundwater flow direction.

Although detailed specifications for well installation may vary in response to site-specific conditions, some elements of well installation are common to most situations. This standard operating procedure (SOP) discusses common methods and minimum standards for monitoring well installation for Tetra Tech EM Inc. (Tetra Tech) projects. The SOP is based on widely recognized methods described by the U.S. Environmental Protection Agency (EPA) and American Society for Testing and Materials (ASTM). However, well type, well construction, and well installation methods will vary with drilling method, intended well use, subsurface characteristics, and other site-specific criteria. In addition, monitoring wells should be constructed and installed in a manner consistent with all local and state regulations. Detailed specifications for well installation should be identified within a site-specific work plan, sampling plan, or quality assurance project plan (QAPP).

General specifications and installation procedures for the following monitoring well components are included in this SOP:

- Monitoring well materials
  - Casing materials
  - Well screen materials
  - Filter pack materials
  - Annular sealant (bentonite pellets or chips)
  - Grouting materials
  - Tremie pipe
  - Surface completion and protective casing materials
  - Concrete surface pad and bumper posts
  - Uncontaminated water
- Monitoring well installation procedures
  - Well screen and riser placement
  - Filter pack placement
  - Temporary casing retrieval
  - Annular seal placement

- Grouting
  - Surface completion and protective casing (aboveground and flush-mount)
  - Concrete surface pad and bumper posts
  - Permanent and multiple casing well installation
- Recordkeeping procedures
  - Surveying
  - Permits and well construction records
  - Monitoring well identification

Well installation methods will depend to some extent on the boring method. Specific boring or drilling protocols are detailed in other SOPs. The boring method, in turn, will depend on site-specific geology and hydrogeology and project requirements. Boring methods commonly used for well installation include:

- Hollow-stem augering
- Cable tool drilling
- Mud rotary drilling
- Air rotary drilling
- Rock coring

The hollow-stem auger method is preferred in areas where subsurface materials are unconsolidated or loosely consolidated and where the depth of the boring will be less than 100 feet. This maximum effective depth for hollow-stem augering depends on the diameter of the augers, the formation characteristics, and the strength and durability of the drilling equipment. This method is preferred because under the right conditions it is cost effective, addition of water into the subsurface is limited, continuous soil samples can easily be collected, and monitoring wells can easily be constructed within the hollow augers.

Cable tool drilling is a preferred method when the subsurface contains boulders, coarse gravels, or flowing sands, or when the operational depth of the hollow-stem auger is exceeded. However, this method is slow.

Rotary methods are generally used when other methods cannot be used. The use of drilling fluids or large amounts of water to maintain an open borehole, and the difficulty in obtaining representative

samples limit the utility of rotary methods. However, rotary methods can be used to quickly and effectively drill deep wells through consolidated or unconsolidated materials. Modifications to this method such as dual-tube drilling procedures, drill-through casing hammers, or eccentric-type drill systems, can reduce the amount of fluids introduced into the well borehole.

Rock coring is an effective method when drilling in competent consolidated rock. Intact, continuous cores can be obtained, and limited amounts of fluid are required if the formations are not fractured.

## **1.1 PURPOSE**

This SOP establishes the requirements and procedures for monitoring well installation. Monitoring wells should be designed to function properly throughout the duration of the monitoring program. The performance objectives for monitoring well installation are as follows:

- Ensure that the monitoring well will provide water samples representative of in situ aquifer conditions.
- Ensure that the monitoring well construction will last for duration of the project.
- Ensure that the monitoring well will not serve as a conduit for vertical migration of contaminants, particularly vertical migration between discrete aquifers.
- Ensure that the well diameter is adequate for all anticipated downhole monitoring and sampling equipment.

## **1.2 SCOPE**

This SOP applies to the installation of monitoring wells. Although some of the procedures may apply to the installation of water supply wells, this SOP is not intended to cover the design and construction of such wells. The SOP identifies several well drilling methods related to monitoring well installation, but the scope of this SOP does not include drilling methods.

Other relevant SOPs include SOP 002 for decontamination of drilling and well installation equipment, SOP 005 for soil sampling, SOP 021 for monitoring well development, SOPs 010 and 015 for

groundwater sampling from monitoring wells, and SOP 014 for measuring static water levels within monitoring wells.

### 1.3 DEFINITIONS

**Annulus:** The space between the monitoring well casing and the wall of the well boring.

**Bentonite seal:** A colloidal clay seal separating the sand pack from the annular grout seal.

**Centralizer:** A stainless-steel or plastic spacer that keeps the well screen and casing centered in the borehole.

**Filter pack:** A clean, uniform sand or gravel placed between the borehole wall and the well screen to prevent formation material from entering the screen.

**Grout seal:** A fluid mixture of (1) bentonite and water, (2) cement, bentonite, and water, or (3) cement and water placed above the bentonite seal between the casing and the borehole wall to secure the casing in place and keep water from entering the borehole.

**Tremie pipe:** A rigid pipe used to place the well filter pack, bentonite seal, or grout seal. The tremie pipe is lowered to the bottom of the well or area to be filled and pulled up ahead of the material being placed.

**Well casing:** A solid piece of pipe, typically polyvinyl chloride (PVC) or stainless steel, used to keep a well open in either unconsolidated material or unstable rock.

**Well screen:** A PVC or stainless steel pipe with openings of a uniform width, orientation, and spacing used to keep materials other than water from entering the well and to stabilize the surrounding formation.

#### 1.4 REFERENCES

- American Society for Testing and Materials. 1995. Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers. D5092-90. West Conshohocken, Pennsylvania.
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- U.S. Environmental Protection Agency (EPA). 1986. RCRA Ground Water Monitoring Technical Enforcement Guidance Document. Office of Solid Waste and Emergency Response. Washington, DC. OSWER-9950-1. September.
- EPA. 1991. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. Office of Research and Development, Environmental Monitoring Systems Laboratory. Washington, DC. EPA/600-4-89/034. March. On-Line Address: <http://www.epa.gov/swrust1/cat/wwelldct.pdf>
- EPA. 1994. Monitor Well Installation. Environmental Response Team SOP #2048 (Rev. #0.0, 03/18/96). On-Line Address: [http://www.ert.org/media\\_resrcs/media\\_resrcs.asp?Child1=](http://www.ert.org/media_resrcs/media_resrcs.asp?Child1=)

#### 1.5 REQUIREMENTS AND RESOURCES

Well installation requires a completed boring with stable or supported walls. The type of drilling rig needed to complete the boring and the well construction materials required for monitoring well installation will depend on the drilling method used, the geologic formations present, and chemicals of concern in groundwater. The rig and support equipment used to drill the borehole is usually used to install the well. Under most conditions, the following items are also required for the proper installation of monitoring wells:

- Tremie pipe and funnel
- Bentonite pellets or chips
- Grouting supplies
- Casing materials
- Well screen materials
- Filter pack materials

- Surface completion materials (protective casing, lockable and watertight well cover, padlock)
- Electronic water level sounding device for water level measurement
- Measuring tape with weight for measuring the depth of the well and determining the placement of filter pack materials
- Decontamination equipment and supplies
- Site-specific work plan, field sampling plan, health and safety plan, and QAPP
- Monitoring Well Completion Record (see Figure 1)

## **2.0 MONITORING WELL INSTALLATION PROCEDURES**

This section presents standard procedures for monitoring well installation and is divided into three subsections. Section 2.1 addresses monitoring well construction materials, while Section 2.2 describes typical monitoring well installation procedures. Section 2.3 addresses recordkeeping requirements associated with monitoring well installation. Monitoring well installation procedures described in work plans, sampling plans, and QAPPs should be fully consistent with the procedures outlined in this SOP as well as any applicable local and state regulations and guidelines.

### **2.1 MONITORING WELL CONSTRUCTION MATERIALS**

Monitoring well construction materials should be specified in the site-specific work plan as well as in the statement of work for any subcontractors assisting in the well installation. Well construction materials that come in contact with groundwater should not measurably alter the chemical quality of groundwater samples with regard to the constituents being examined. The riser, well screen, and filter pack and annular sealant placement equipment should be steam cleaned or high-pressure water cleaned immediately prior to well installation. Alternatively, these materials can be certified by the manufacturer as clean and delivered to the site in protective wrapping. Samples of the filter pack, annular seal, and mixed grout should be retained as a quality control measure until at least one round of groundwater sampling and analysis is completed.

This section discusses material specifications for the following well construction components: casing, well screen, filter pack, annular sealant (bentonite pellets or chips), grout, tremie pipes, surface

completion components (protective casing, lockable and water tight cap, and padlock), concrete surface pad, and uncontaminated water. Figure 2 shows the construction details of a typical monitoring well.

#### **2.1.1 Casing Materials**

The material type and minimum wall thickness of the casing should be adequate to withstand the forces of installation. If the casing has not been certified as clean by the manufacturer or delivered to and maintained in clean condition at the site, the casing should be steam cleaned or high-pressure water cleaned with water from a source of known chemistry immediately prior to installation (see Tetra Tech SOP No. 002). The ends of each casing section should be either flush-threaded or beveled for welding.

Schedule 40 or Schedule 80 PVC casing is typically used for monitoring well installation. Either type of casing is appropriate for monitoring wells with depths less than 100 feet below ground surface (bgs). If the well is deeper than 100 feet bgs, Schedule 80 PVC should be used.

Stainless steel used for well casing is typically Type 304 and is of 11-gauge thickness.

#### **2.1.2 Well Screen Materials**

Well screens should be new, machine-slotted or continuous wrapped wire-wound, and composed of materials most suited for the monitoring environment based on site characterization findings. Well screens are generally constructed of the same materials used for well casing (PVC or stainless steel). The screen should be plugged at the bottom with the same material as the well screen. Alternatively, a short (1- to 2-foot) section of casing material with a bottom (sump) should be attached below the screen. This assembly must be able to withstand installation and development stresses without becoming dislodged or damaged. The length of the slotted area should reflect the interval to be monitored.

If the well screen has not been certified as clean by the manufacturer or delivered to and maintained in clean condition at the site, the screen should be steam cleaned or high-pressure water cleaned with water from a source of known chemistry immediately prior to installation (see Tetra Tech SOP No. 002).

The minimum internal diameter of the well screen should be chosen based on the particular application. A minimum diameter of 2 inches is usually needed to allow for the introduction and withdrawal of sampling devices. Typical monitoring well screen diameters are 2 inches and 4 inches.

The slot size of the well screen should be determined relative to (1) the grain size of particles in the aquifer to be monitored and (2) the gradation of the filter pack material.

Screen length and monitoring well diameter will depend on site-specific considerations such as intended well use, contaminants of concern, and hydrogeology. Some specific considerations include the following:

- Water table wells should have screens of sufficient length and diameter to monitor the water table and provide sufficient sample volume under high and low water table conditions.
- Wells with low recharge should have screens of sufficient length and diameter so that adequate sample volume can be collected.
- Wells should be screened over sufficiently short intervals to allow for monitoring of discrete migration pathways.
- Where light nonaqueous-phase liquids (LNAPL) or contaminants in the upper portion of a hydraulic unit are being monitored, the screen should be set so that the upper portion of the water-bearing zone is below the top of the screen.
- Where dense nonaqueous-phase liquids (DNAPL) are being monitored, the screen should be set within the lower portion of the water-bearing zone, just above a relatively impermeable lithologic unit.
- The screened interval should not extend across an aquiclude or aquitard.
- If contamination is known to be concentrated within a portion of a saturated zone, the screen should be constructed in a manner that minimizes the potential for cross-contamination within the aquifer.
- If downhole geophysical surveys are to be conducted, the casing and screen must be of sufficient diameter and constructed of the appropriate material to allow for effective use of the geophysical survey tools.
- If aquifer tests are to be conducted in a monitoring well, the slot size must allow sufficient flux to produce the required drawdown and recovery. The diameter of the well must be sufficient to house the pump and monitoring equipment, and allow sufficient



water flux (in combination with the screen slot size) to produce the required drawdown or recovery.

### **2.1.3 Filter Pack Materials**

The primary filter pack consists of a granular material of known chemistry and selected grain size and gradation. The filter pack is installed in the annulus between the well screen and the borehole wall. The grain size and gradation of the filter pack are selected to stabilize the hydrologic unit adjacent to the screen and to prevent formation material from entering the well during development. After development, a properly filtered monitoring well is relatively free of turbidity.

A secondary filter pack is a layer of material placed in the annulus directly above the primary filter pack and separates the filter pack from the annular sealant. The secondary filter pack should be uniformly graded fine sand, with 100 percent by weight passing through a No. 30 U.S. Standard sieve, and less than 2 percent by weight passing through a No. 200 U.S. Standard sieve.

### **2.1.4 Annular Sealant (Bentonite Pellets or Chips)**

The materials used to seal the annulus may be prepared as a slurry or used as dry pellets, granules, or chips. Sealants should be compatible with ambient geologic, hydrogeologic, and climatic conditions and any man-induced conditions anticipated to occur during the life of the well.

Bentonite (sodium montmorillonite) is the most commonly used annular sealant and is furnished in sacks or buckets in powder, granular, pelletized, or chip form. Bentonite should be obtained from a commercial source and should be free of impurities that may adversely impact the water quality in the well. Pellets are compressed bentonite powder in roughly spherical or disk shapes. Chips are large, coarse, irregularly shaped units of bentonite. The diameter of the pellets or chips should be less than one-fifth the width of the annular space into which they will be placed in order to reduce the potential for bridging. Granules consist of coarse particles of unaltered bentonite, typically smaller than 0.2 inch in diameter. Bentonite slurry is prepared by mixing powdered or granular bentonite with water from a source of known chemistry.

### **2.1.5 Grouting Materials**

The grout backfill that is placed above the bentonite annular seal is ordinarily liquid slurry consisting of either (1) a bentonite (powder, granules, or both) base and water, (2) a bentonite and Portland cement base and water, or (3) a Portland cement base and water. Often, bentonite-based grouts are used when flexibility is desired during the life of the well installation (for example, to accommodate freeze-thaw cycles). Cement- or bentonite-based grouts are often used when cracks in the surrounding geologic material must be filled or when adherence to rock units, or a rigid setting is desired.

Each type of grout mixture has slightly different characteristics that may be appropriate under various physical and chemical conditions. However, quick-setting cements containing additives are not recommended for use in monitoring well installation because additives may leach from the cement and influence the chemistry of water samples collected from the well.

### **2.1.6 Tremie Pipe**

A tremie pipe is used to place the filter pack, annular sealant, and grouting materials into the borehole. The tremie pipe should be rigid, have a minimum internal diameter of 1.0 inch, and be made of PVC or steel. The length of the tremie pipe should be sufficient to extend to the full depth of the monitoring well.

### **2.1.7 Surface Completion and Protective Casing Materials**

Protective casings that extend above the ground surface should be made of aluminum, steel, stainless steel, cast iron, or a structural plastic. The protective casing should have a lid with a locking device to prevent vandalism. Sufficient clearance, usually 6 inches, should be maintained between the top of the riser and the top of protective casing. A water-tight well cap should be placed on the top of the riser to seal the well from surface water infiltration in the event of a flood. A weep hole should be drilled in the casing a minimum of 6 inches above the ground surface to enable water to drain out of the annular space.

Flush-mounted monitoring wells (wells that do not extend above ground surface) require a water-tight protective cover of sufficient strength to withstand heavy traffic. The well riser should be fitted with a locking water-tight cap.

#### **2.1.8 Concrete Surface Pad and Bumper Posts**

A concrete surface pad should be installed around each well when the outer protective casing is installed. The surface pad should be formed around the well casing. Concrete should be placed into the formed pad and into the borehole (on top of the grout), typically to a depth of 1 to 3 feet bgs (depending on state, federal, and local regulations). The protective casing is then installed into the concrete. As a general guideline, if the well casing is 2 inches in diameter, the concrete pad should be 3 feet square and 4 inches thick. If the well casing is 4 inches in diameter, the pad should be 4 feet square and 6 inches thick. Round concrete pads are also acceptable.

The finished pad should be sloped so that drainage flows away from the protective casing and off the pad. The finished pad should extend at least 1 inch below grade. If the monitoring wells are located in high traffic areas, a minimum of three bumper posts should be installed around the pad to protect the well. Bumper posts, consisting of steel pipes 3 to 4 inches in diameter and at least 5 feet long, should be installed in a radial pattern around the protective casing, beyond the edges of the cement pad. The base of the bumper posts should be installed 2 feet bgs in a concrete footing; the top of the post should be capped or filled with concrete.

#### **2.1.9 Uncontaminated Water**

Water used in the drilling process, to prepare grout mixtures, and to decontaminate the well screen, riser, and annular sealant injection equipment, should be obtained from a source of known chemistry. The water should not contain constituents that could compromise the integrity of the monitoring well installation.

## **2.2 MONITORING WELL INSTALLATION PROCEDURES**

This section describes the procedures used to install a single-cased monitoring well, with either temporary casing or hollow-stem augers to support the walls of the boring in unconsolidated formations. The procedures are described in the order in which they are conducted, and include: (1) placement of well screen and riser pipe, (2) placement of filter pack, (3) progressive retrieval of temporary casing, (4) placement of annular seal, (5) grouting, (6) surface completion and installation of protective casing, and (7) installation of concrete pad and bumper posts.

The additional steps necessary to install a well with permanent or multiple casing strings are described at the end of this section.

### **2.2.1 Well Screen and Riser Placement**

After the total depth of the boring is confirmed and the well screen depth interval and the height of the aboveground completion are determined, the screen and riser is assembled from the bottom up as it is lowered down the hole. The following procedures should be followed:

1. Measure the total depth of the boring using a weighted tape.
2. Determine the length of screen and casing materials required to construct the well.
3. Assemble the well parts from the bottom up, starting with the well sump or cap, well screen, and then riser pipe. Progressively lower the assembled length of pipe.
4. The length of the assembled pipe should not extend above the top of the installation rig.

The well sump or cap, well screen, and riser should be certified clean by the manufacturer or should be decontaminated before assembly and installation. No grease, oil, or other contaminants should contact any portion of the assembly. Flush joints should be tightened, and welds should be water tight and of good quality. The riser should extend above grade and be capped temporarily to prevent entrance of foreign materials during the remaining well completion procedures.

When the well screen and riser assembly is lowered to the predetermined level, it may float and require a method to hold it in place. For borings drilled using cable tool or air rotary drilling methods, centralizers should be attached to the riser at intervals of between 20 and 40 feet.

### **2.2.2 Filter Pack Placement**

The filter pack is placed after the well screen and riser assembly has been lowered into the borehole. The steps below should be followed:

1. Determine the volume of the annular space in the filter pack interval. The filter pack should extend from the bottom of the borehole to at least 2 feet above the top of the well screen.
2. Assemble the required material (sand pack and tremie pipe).
3. Lower a clean or decontaminated tremie pipe down the annulus to within 1 foot of the base of the hole.
4. Pour the sand down the tremie pipe using a funnel; pour only the quantity estimated to fill the first foot.
5. Check the depth of sand in the hole using a weighted tape.
6. Pull the drill casing up ahead of the sand to keep the sand from bridging.
7. Continue with this process (steps 4 through 6) until the filter pack is at the appropriate depth.

If bridging of the filter pack occurs, break out the bridge prior to adding additional filter pack material. For wells less than 30 feet deep installed inside hollow-stem augers, the sand may be poured in 1-foot lifts without a tremie pipe.

Sufficient measurements of the depth to the filter pack material and the depth of the bottom of the temporary casing should be made to ensure that the casing bottom is always above the filter pack. The filter pack should extend 2 feet above the well screen (or more if required by state or local regulations). However, the filter pack should not extend across separate hydrogeologic units. The final depth interval, volume, and type of filter pack should be recorded on the Monitoring Well Completion Record (Figure 1).

A secondary filter pack may be installed above the primary filter pack to prevent the intrusion of the bentonite grout seal into the primary filter pack. A measured volume of secondary filter material should be added to extend 1 to 2 feet above the primary filter pack. As with the primary filter pack, a secondary filter pack must not extend into an overlying hydrologic unit. An on-site geologist should evaluate the

need for a secondary filter pack by considering the gradation of the primary filter pack, the hydraulic head difference between adjacent units, and the potential for grout intrusion into the primary filter pack.

The secondary filter material is poured into the annular space through tremie pipe as described above. Water from a source of known chemistry may be added to help place the filter pack into its proper location. The tremie pipe or a weighed line inserted through the tremie pipe can be used to measure the top of the secondary filter pack as work progresses. The amount and type of secondary filter pack used should be recorded on the Monitoring Well Completion Record (Figure 1).

#### **2.2.3 Temporary Casing Retrieval**

The temporary casing or hollow-stem auger should be withdrawn in increments. Care should be taken to minimize lifting the well screen and riser assembly during withdrawal of the temporary casing or auger. It may be necessary to place the top head of the rig on the riser to hold it down. To limit borehole collapse in formations consisting of unconsolidated materials, the temporary casing or hollow-stem auger is usually withdrawn until the lowest point of the casing or auger is at least 2 feet, but no more than 5 feet, above the filter pack. When the geologic formation consists of consolidated materials, the lowest point of the casing or auger should be at least 5 feet, but no more than 10 feet, above the filter pack. In highly unstable formations, withdrawal intervals may be much less. After each increment, the depth to the primary filter pack should be measured to check that the borehole has not collapsed or that bridging has not occurred.

#### **2.2.4 Annular Seal Placement**

A bentonite pellet, chip, or slurry seal should be placed between the borehole and the riser on top of the primary or secondary filter pack. This seal retards the movement of grout into the filter pack. The thickness of the bentonite seal will depend on state and local regulations, but the seal should generally be between 3 and 5 feet thick.

The bentonite seal should be installed using a tremie pipe, lowered to the top of the filter pack and slowly raised as the bentonite pellets or slurry fill the space. Care must be taken so that bentonite pellets or

chips do not bridge in the augers or tremie pipe. The depth of the seal should be checked with a weighted tape or the tremie pipe.

If a bentonite pellet or chip seal is installed above the water level, water from a known source should be added to allow proper hydration of the bentonite. Sufficient time should be allowed for the bentonite seal to hydrate. The volume and thickness of the bentonite seal should be recorded on the Monitoring Well Completion Record (Figure 1).

### **2.2.5 Grouting**

Grouting procedures vary with the type of well design. The volume of grout needed to backfill the remaining annular space should be calculated and recorded on the Monitoring Well Completion Record (Figure 1). The use of alternate grout materials, including grouts containing gravel, may be necessary to control zones of high grout loss. Bentonite grouts should not be used in arid regions because of their propensity to desiccate. Typical grout mixtures include the following:

- Bentonite grout: about 1 to 1.25 pounds of bentonite mixed with 1 gallon of water
- Cement-bentonite grout: about 5 pounds of bentonite and one 94-pound bag of cement mixed with 7 to 8 gallons of water
- Cement grout: one 94-pound bag of cement mixed with 6 to 7 gallons of water

The grout should be installed by gravity feed through a tremie pipe. The grout should be mixed in batches in accordance with the appropriate requirements and then pumped into the annular space until full-strength grout flows out at the ground surface without evidence of drill cuttings or fluid. The tremie pipe should then be removed to allow the grout to cure.

The riser should not be disturbed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and riser. For bentonite grouts, curing times are typically around 24 hours; curing times for cement grouts are typically 48 to 72 hours. However, the curing time required will vary with grout content and climatic conditions. The curing time should be documented in the Monitoring Well Completion Record (Figure 1).

#### **2.2.6 Surface Completion and Protective Casing**

Aboveground completion of the monitoring well should begin once the grout has set (no sooner than 24 hours after the grout was placed). The protective casing is lowered over the riser and set into the cured grout. The protective casing should extend below the ground surface to a depth below the frost line (typically 3 to 5 feet, depending on local conditions). The protective casing is then cemented in place. A minimum of 6 inches of clearance should be maintained between the top of the riser and the protective casing. A 0.5-inch diameter drainage or weep hole should be drilled in the protective casing approximately 6 inches above the ground surface to enable water to drain out of the annular space between the casing and riser. A water-tight cap should be placed on top of the riser to seal the well from surface water infiltration in the event of a flood. A lock should be placed on the protective casing to prevent vandalism.

For flush-mounted monitoring wells, the well cover should be raised above grade and the surrounding concrete pad sloped so that water drains away from the cover. The flush-mount completion should be installed in accordance with applicable state and local regulations.

#### **2.2.7 Concrete Surface Pad and Bumper Posts**

The concrete pad installed around the monitoring well should be sloped so that the drainage will flow away from the protective casing and off the pad. The finished pad should extend at least 1 inch below grade. If the monitoring wells are located in high traffic areas, a minimum of three bumper posts should be installed in a radial pattern around the protective casing, outside the cement pad. Specifications for concrete surface pads and bumper posts are described in Section 2.1.8.

#### **2.2.8 Permanent and Multiple Casing Well Installation**

When wells are installed through multiple saturated zones, special well construction methods should be used to assure well integrity and limit the potential for cross-contamination between geologic zones. Generally, these types of wells are necessary if relatively impermeable layers separate hydraulic units. Two procedures that may be used are described below.



In the first procedure, the borehole is advanced to the base of the first saturated zone. Casing is then anchored in the underlying impermeable layer (aquitar) by advancing the casing at least 1 foot into the aquitar and grouting to the surface. After the grout has cured, a smaller diameter borehole is drilled through the grout. This procedure is repeated until the zone of interest is reached. After the zone is reached, a conventional well screen and riser are set. A typical well constructed in this manner is shown on Figure 3.

A second acceptable procedure involves driving a casing through several saturated layers while drilling ahead of the casing. However, this method is not acceptable when the driven casing may structurally damage a competent aquitar or aquiclude and result in cross-contamination of the two saturated layers. This method should also be avoided when highly contaminated groundwater or nonaqueous-phase contamination may be dragged down into underlying uncontaminated hydrologic units.

## **2.3 RECORDKEEPING PROCEDURES**

Recordkeeping procedures associated with monitoring well installation are described in the following sections. These include procedures for surveying, obtaining permits, completing well construction records, and identifying monitoring wells.

### **2.3.1 Surveying**

Latitude, longitude, and elevation at the top of the riser should be determined for each monitoring well. A permanent notch or black mark should be made on the north side of the riser. The top of the riser and ground surface should be surveyed.

### **2.3.2 Permits and Well Construction Records**

Local and state regulations should be reviewed prior to monitoring well installation, and any required well permits should be in-hand before the driller is scheduled.

Monitoring well installation activities should be documented in both the field logbook and on the Monitoring Well Completion Record (Figure 1). Geologic logs should be completed and, if necessary, filed with the appropriate regulatory agency within the appropriate time frame.

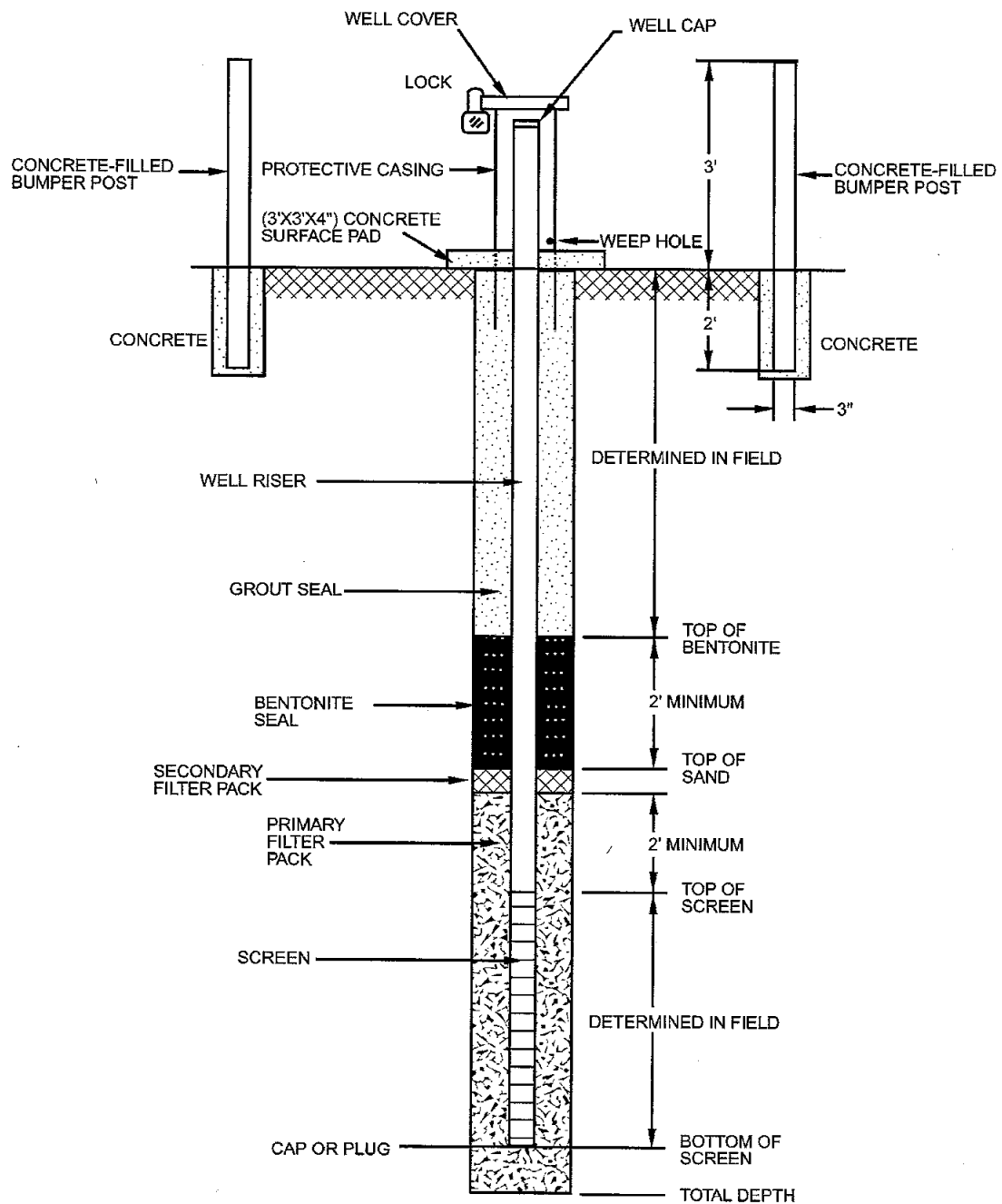
### **2.3.3 Monitoring Well Identification**

Each monitoring well should have an individual well identification number or name. The well identification may be stamped in the metal surface upon completion or permanently marked by using another method. Current state and local regulations should be checked for identification requirements (such as township, range, section, or other identifiers in the well name).

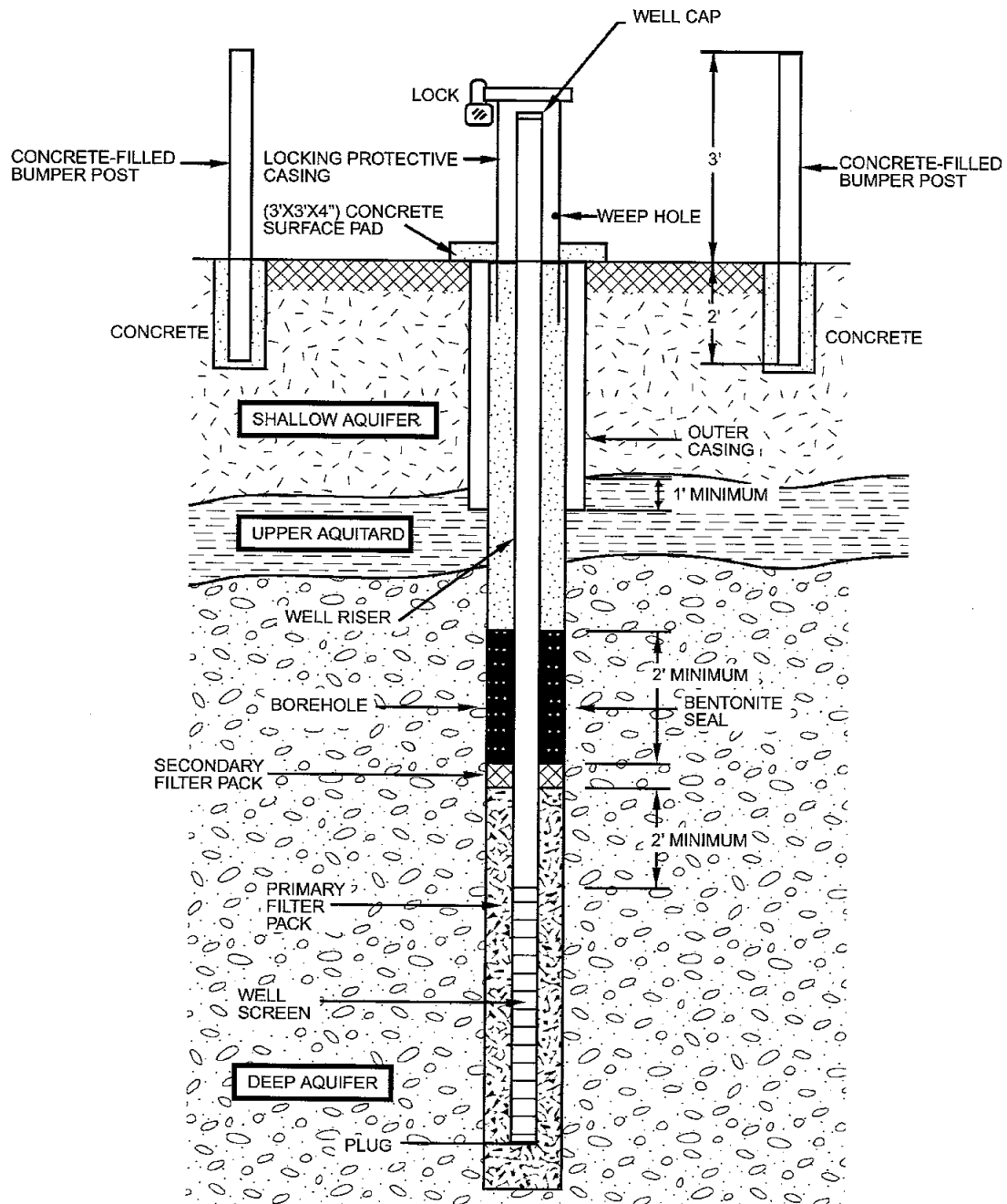
**FIGURE 1**  
**MONITORING WELL COMPLETION RECORD**

<b>TETRATECH EM INC</b>		<b>MONITORING WELL COMPLETION RECORD</b>	
<b>MONITORING WELL</b> MONITORING WELL NO.: _____ PROJECT: _____ SITE: _____ BOREHOLE NO.: _____ WELL PERMIT NO.: _____ TOC TO BOTTOM OF WELL: _____	<b>SURFACE COMPLETION</b> <input type="checkbox"/> FLUSH MOUNT <input type="checkbox"/> ABOVE GROUND WITH BUMPER POST <input type="checkbox"/> CONCRETE <input type="checkbox"/> ASPHALT	<b>SURVEY INFORMATION</b> TOC ELEVATION: _____ GROUND SURFACE ELEVATION: _____ NORTHING: _____ EASTING: _____ DATE SURVEYED: _____ SURVEY CO.: _____	
<b>DRILLING INFORMATION</b> DRILLING BEGAN: _____ DATE: _____ TIME: _____ WELL INSTALLATION BEGAN: _____ DATE: _____ TIME: _____ WELL INSTALLATION FINISHED: _____ DATE: _____ TIME: _____ DRILLING CO.: _____ DRILLER: _____ LICENSE: _____ DRILL RIG: _____ DRILLING METHOD: <input type="checkbox"/> HOLLOW-STEM AUGER <input type="checkbox"/> AIR ROTARY <input type="checkbox"/> OTHER: _____ DIAMETER OF AUGERS: ID: _____ OD: _____			
<b>WELL CASING</b> <input type="checkbox"/> SCHEDULE 40 PVC <input type="checkbox"/> OTHER: _____ PRODUCT: _____ MFG. BY: _____ CASING DIAMETER: ID: _____ OD: _____ LENGTH OF CASING: _____	<b>ANNULAR SEAL</b> VOLUME CALCULATED: _____ AMOUNT USED: _____ <input type="checkbox"/> GROUT FORMULA (PERCENTAGES) PORTLAND CEMENT: _____ BENTONITE: _____ WATER: _____ <input type="checkbox"/> PREPARED MIX PRODUCT: _____ MFG. BY: _____ METHOD INSTALLED: <input type="checkbox"/> POURED <input type="checkbox"/> TREMIE <input type="checkbox"/> OTHER: _____		
<b>WELL SCREEN</b> <input type="checkbox"/> SCHEDULE 40 PVC <input type="checkbox"/> OTHER: _____ PRODUCT: _____ MFG. BY: _____ CASING DIAMETER: ID: _____ OD: _____ SLOT SIZE: _____ LENGTH OF SCREEN: _____	<b>BENTONITE SEAL</b> VOLUME CALCULATED: _____ AMOUNT USED: _____ <input type="checkbox"/> PELLETS, SIZE: _____ <input type="checkbox"/> CHIPS, SIZE: _____ <input type="checkbox"/> OTHER: _____ PRODUCT: _____ MFG. BY: _____ METHOD INSTALLED: <input type="checkbox"/> POURED <input type="checkbox"/> TREMIE <input type="checkbox"/> OTHER: _____ AMOUNT OF WATER USED: _____		
<b>BOREHOLE BACKFILL</b> AMOUNT CALCULATED: _____ AMOUNT USED: _____ <input type="checkbox"/> BENTONITE CHIPS, SIZE: _____ <input type="checkbox"/> BENTONITE PELLETS, SIZE: _____ <input type="checkbox"/> SLURRY: _____ <input type="checkbox"/> FORMATION COLLAPSE: _____ <input type="checkbox"/> OTHER: _____ PRODUCT: _____ MFG. BY: _____ METHOD INSTALLED: <input type="checkbox"/> POURED <input type="checkbox"/> TREMIE <input type="checkbox"/> OTHER: _____	<b>FILTER PACK</b> <input type="checkbox"/> PREPACKED FILTER VOLUME CALCULATED: _____ AMOUNT USED: _____ <input type="checkbox"/> SAND, SIZE: _____ PRODUCT: _____ MFG. BY: _____ METHOD INSTALLED: <input type="checkbox"/> POURED <input type="checkbox"/> TREMIE <input type="checkbox"/> OTHER: _____ WATER LEVEL: _____ (BTOC AFTER WELL INSTALLATION)		
<b>CENTRALIZERS USED?</b> <input type="checkbox"/> YES <input type="checkbox"/> NO; CENTRALIZER DEPTHS: _____			
<b>LEGEND</b> BGS = BELOW GROUND SURFACE BTOC = BELOW TOP OF CASING N/A = NOT APPLICABLE NR = NOT RECORDED TOC = TOP OF CASING ID = INSIDE DIAMETER OD = OUTSIDE DIAMETER			

**FIGURE 2**  
**MONITORING WELL CONSTRUCTION DIAGRAM**



**FIGURE 3**  
**MULTIPLE CASING WELL CONSTRUCTION DIAGRAM**



**SOP APPROVAL FORM**

TETRA TECH EM INC.

ENVIRONMENTAL STANDARD OPERATING PROCEDURE

**BOREHOLE LOGGING**

**SOP NO. 026**

**REVISION NO. 2**

Last Reviewed: November 1999

*February 2, 1993*

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Quality Assurance Approved

Date

## **1.0 BACKGROUND**

The objective of logging a borehole is to document the details of the soil and rock recovered from the borehole. These details include soil type, color, grain size variation, grain characteristics, staining, odor, moisture content, plasticity, blowcounts, soil sample interval, soil recovery, and sample numbers. These data are used to reconstruct the borehole's stratigraphy, which can then be correlated with similar data from other boreholes in the region to produce geological and hydrogeological cross sections. These cross sections, along with various soil characteristics, and additional hydrogeological data, are used to prepare models that show the migration of groundwater and of any associated contaminants.

Tetra Tech EM Inc. (Tetra Tech) has adopted a modified version of the Unified Soil Classification System (USCS) for borehole logging. The USCS classifies soils based on texture and liquid limits. The system consists of 15 soil groups, each identified by a two-letter symbol. The major divisions within the USCS (the first letter in each two-letter symbol) denote particle size: coarse-grained soils are sands (S) and gravels (G); fine-grained soils are silts (M) and clays (C). In coarse-grained soils, the second letter in the classification refers to the grading (sorting) of the soils. Thus (W) represents clean, well graded (poorly sorted) materials, while (P) represents clean, poorly graded (well sorted) materials. In fine-grained soils, the silts and clays are further subdivided in terms of liquid limits, with (L) indicating soils with low liquid limits and (H) representing soils with high liquid limits.

### **1.1 PURPOSE**

The purpose of this standard operating procedure (SOP) is to ensure that all the pertinent information that can be obtained from drilling a borehole is logged completely, accurately, and consistently.

### **1.2 SCOPE**

This SOP applies to all Tetra Tech personnel involved in the logging of a borehole. Preprinted borehole log forms are available, and all personnel involved in borehole logging will use a form to document field activities. Attachment A contains a sample field borelog form.

### **1.3 DEFINITIONS**

Definitions of terms that relate to borehole logging are presented below. Definitions of soil types are taken from the American Society for Testing and Materials ([ASTM 1985](#)).

**Blow Counts:** The number of blows delivered by a 140-pound hammer dropped 30 inches required to drive a 1.5-inch inside diameter core sampler down a certain depth, generally 6 inches.

**Unified Soil Classification System (USCS):** A geotechnical classification in which soils are classified into four major divisions (coarse-grained, fine-grained, organic soils, and peat). The coarse-grained soils are classified according to grain size, whereas the fine-grained soils are classified according to plasticity characteristics. A total of 15 soil types are recognized. Each is indicated by a different two-letter group symbol, such as SP, ML, and GW.

**Well Graded Sediment/Soil:** An engineering term describing a soil or unconsolidated sediment consisting of particles of several or many sizes. The opposite is “poorly graded,” in which the soil or sediment particles are of nearly the same size. In the geological literature, “well graded” and “poorly graded” sediments/soils are referred to as “poorly sorted” and “well sorted,” respectively.

**Clay:** A fine-grained soil passing a No. 200 (75-micron [ $\mu\text{m}$ ]) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents and that exhibits considerable strength when air-dry.

**Gravel:** Particles of rock that will pass a 3-inch (75-millimeter [mm]) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions: coarse - passes a 3-inch (75-mm) sieve and is retained on a 0.75-inch (19-mm) sieve; fine - passes a 0.75-inch (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

**Organic Clay:** A clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 percent of its liquid limit value before oven drying.

**Peat:** A soil composed primarily of vegetable tissue in various stages of decomposition, usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

**Sand:** Particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75- $\mu\text{m}$ ) sieve with the following subdivisions: coarse - passes a No. 4 (4.75-mm) sieve and is retained on No. 10 (2.00-mm) sieve; medium - passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425- $\mu\text{m}$ ) sieve; fine - passes a No. 40 (425- $\mu\text{m}$ ) sieve and is retained on a No. 200 (75- $\mu\text{m}$ ) sieve.



**Silt:** A fine-grained soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry.

## 1.4 REFERENCES

American Geological Institute (AGI). 1972. "Data Sheet." Alexandria, Virginia.

AGI. 1987. *Glossary of Geology*. Alexandria, Virginia.

American Society for Testing and Materials (ASTM). 1985. *Annual Book of ASTM Standard*. Philadelphia, Pennsylvania.

Fetter, C.W. 1988. *Applied Hydrogeology*. Merrill Publishing Company. Columbus, Ohio.

Holtz, R.D., and W.D. Kovacs. 1981. *An Introduction to Geotechnical Engineering*. Prentice-Hall Inc. Englewood Cliffs, New Jersey.

## 1.5 REQUIREMENTS AND RESOURCES

To log the borehole, one person at the drill site should be a geoscientist or someone who has a knowledge of soil types and their physical characteristics. The following supplies will be required at the drill site for borehole logging:

**Clipboard:** Provides a support for completing the field borelog forms. A suitable clipboard measures 12 by 9 inches, is hinged, and of three-leaf metal construction with up to a 1-inch depth for storing papers, borehole log forms, field notebooks, and so on. Tetra Tech has provided a variety of frequently used items such as a laminated color chart, Tetra Tech EM Inc. - Environmental SOP No. 026 USCS table, and examples of soil samples on the metal clipboards for reference in the field.

**Borehole Log Form:** A preprinted blank form on which all the subsurface information is noted. Tetra Tech has designed and printed this form for all borehole logging purposes. A completed sample field borelog form is presented in Attachment A.

**United Soil Classification System (USCS) Table:** A USCS table is needed to determine the group to which any retrieved soil belongs. Tetra Tech has laminated a copy of this table on the metal clipboards for reference in the field.

**Color Chart:** Contains all the possible rock, sediment, and soil colors with which the material retrieved from the borehole can be compared. In this chart, the color is described (for example, light brownish gray) and given a corresponding color code (for example, 5 YR 6/1). The Munsell Soil Color Chart or the Geological Society of America rock color chart can be used.

**Hand Lens:** A pocket-size magnifying glass with a magnification of approximately 10 to 20 times. It is particularly helpful in examining fine-grained materials in order to accurately describe the composition, shape, size, roundness, and color of the rock/soil particles.

**Pocket Knife:** Used to split recovered soil samples in any desired direction. It is also a convenient tool for isolating part of a soil/sediment sample for closer examination.

**Hammer:** Has many possible uses at the drill site. It is particularly handy for splitting borehole samples of rocks.

**Sample Bottles:** Used to collect soil and ground water samples retrieved during boring.

**Ruler:** A 1-foot ruler with markings in millimeters and fractions of an inch will be needed to measure the diameters of coarse-grained sediments.

**Adhesive Tape, Scissors, and Markers:** Useful for securing the sample bottle caps and for labeling the bottles.

**Soil Samples for Reference:** Small samples of various soil types that are classified by grain size and roundness. These samples serve as a useful reference in maintaining consistency in classifying borehole soils at the drill site. Tetra Tech has laminated some examples of prominent soil samples on the metal clipboards for reference in the field.

**Hydrochloric Acid:** A small bottle of dilute hydrochloric acid (HCl) consisting of one part HCl to three parts water. This will be used to identify calcium carbonate-bearing soils or sediments.

**Miscellaneous Reference Charts:** These charts include explanations and drawings of technical terms that are frequently used in logging boreholes. Examples include a soil description summary table (see Attachment B), cohesive

soil consistency chart, blow counts versus soil stiffness correlation chart, granular soil density chart, moisture table, percentage-composition estimation chart, and particle roundness sketches. Tetra Tech has laminated these charts on metal clipboards for reference in the field.

**Photoionization Detector (PID):** Used to monitor possible emissions of hazardous gases from the borehole. The unit comes with an operating instruction manual.

**Moisture Measuring Unit:** Used to measure the moisture content of a soil sample in the field. The unit comes with operating instructions.

**Draeger Tube:** A colorimetric tube used to measure the concentrations of a variety of inorganic and organic vapors and gases. Allows on-site personnel to take necessary health and safety precautions. The unit comes with operating instructions.

**Combustible Gas Indicator:** Used to monitor the level of combustible gases that may be present at the drill site. Warns on-site personnel of any danger of explosion. It is of special value for drilling at sites that have a potential for emitting methane.

**Work Table:** The table is needed to set up equipment, borehole samples, and various supplies.

**Tent or Canopy:** Used to protect the field borelog forms and other documents from rain or snow.

## **2.0 PROCEDURE**

The following subsections detail the procedure for borehole logging.

### **2.1 GETTING ORGANIZED AT THE DRILL SITE**

Borehole logging requires setting up a small office and a small laboratory at the drill site. As the borehole material is pulled up and retrieved for sampling, testing, or inspection, a variety of subtasks must be completed in a certain sequence and in a limited time span. It is

important, therefore, that all the supplies and equipment be well organized and the tasks be clearly understood by the persons who are supposed to log the borehole.

### **2.2 LOGGING A BOREHOLE**

Preprinted borelog forms are available to ensure that pertinent information is recorded by field personnel. Borelog forms will be completed by field personnel during drilling operations.

Instructions for completing the sample form (see Attachments A and B) are given below.

1. General: At the beginning of each day, use a new borelog sheet. The new sheet should continue at the depth where previous day's drilling was terminated.

Where appropriate, use the following abbreviations:

M	=	Missing
NA	=	Not applicable
ND	=	Not done

2. Location of Borehole: Draw a sketch map of the borehole site in the space provided at the upper left corner of the borelog form. Mark the precise location of the borehole with an "X" and clearly label it (for example, BH-12). Also draw and label prominent features in the vicinity of the borehole, such as railroads, streets, buildings, fence lines, and other landmarks. The direction to north should be shown (T N). Give an approximate scale.
3. Job No., Client, etc.: Enter this information as appropriate. Print the name(s) of the person(s) who logged the segment shown on any particular page of the borelog form.
4. Site, Subsite, Borehole Designation, etc.: This part of the form is self-explanatory. Enter "Sheet\_\_of\_\_" on each page after the borehole is completed.
5. Sampler Type: Choose abbreviations from the following list:

CHP	=	Constant head probe
GP	=	Geoprobe
GWP	=	Groundwater probe
SGP	=	Soil-gas probe
SS	=	Split spoon
ST	=	Shelby tube
__	=	Other (specify)

6. Sample Depth: Record the top and bottom depths of the segment drilled. The fraction of a foot should be recorded in decimals (for example, 5.6 feet) and not in inches.
7. Blows/6" Sampler: Record the number of blows in each 6-inch interval. If more than 100 blows are counted in the 6-inch interval, then record only 100. In this column, the hammer weight should be entered immediately below the blow count for the first entry of each day, after which the hammer weight should be recorded only if it is changed.
8. Inches Recovered/Driven: This column is self-explanatory.
9. Time: Record the exact time when the sample was collected in military time (for example, 1715 hours)
10. PID Reading: Record the PID reading in parts per million (ppm) units.
11. Analyses (Physical/Chemical): Record the number of containers that will be sent for each type of analysis (physical "Phy" and/or chemical "Chm"). If no sample will be sent for analysis, a zero (0) should be recorded in the appropriate sub-column.
12. Depth in Feet: Enter numerals before or after the preprinted numerals to indicate the depth as multiples of 1 or 10. At the beginning of each day, a new borelog sheet should be used (see item 1 above). The boxes should be used to document soil types and depths.
13. USCS Soil Type: Enter appropriate USCS abbreviations (SW, SP, ML, and so on) based on the soil description in the next column. Complete this column only after the soil types have been described.
14. Soil Description: Record the soil description, noting the following items: soil type, color (with code from the color chart), texture (grain size, roundness, and so on), bedding, odor, consistency (stiffness, plasticity, and so on, for cohesive soils), relative density (loose, dense, and so on, for granular soils), and moisture content (dry, moist, saturated, and so on). The "Field Descriptions for Soil Summary Table" provided in Attachment B can be used to aid in the description formulation process. Record the depth of the water table where it is encountered. The presence of the water table should be indicated by writing down "saturated at \_\_\_ feet." Soil classified as "sand" should be further categorized as well graded (SW) or poorly-graded (SP). It should be remembered that the term "well graded" in geotechnology is the opposite of "well sorted" in geology. Record the sample medium and sample tag number, as necessary.

15. When the borehole is terminated, enter "Borehole terminated at - feet."

**ATTACHMENT A**  
**SAMPLE FIELD BORELOG FORM**

# FIELD BORELOG

Sheet \_\_\_\_ of \_\_\_\_

Location of Borehole								Job No.:		Borehole Designation	
								Client:		Surface Elevation:	
								Site:		Depth to Water:	
								Subsite:		Logged by:	
								Drilling Co.:		Drilling Date(s):	
								Drilling Personnel/Method:			
Sampler Type	Sample Depth		Blows /6" Sample	Inches Recov'd /Driven	Time	PID Reading	Analysis		Depth (Ft)	USCS Soil Type	Soil Description and Notes
	T o p	B o t					Phys	Chm			
									1		
									2		
									3		
									4		
									5		
									6		
									7		
									8		
									9		
									0		
									1		
									2		
									3		
									4		
									5		
									6		
									7		

## ATTACHMENT A

### FIELD DESCRIPTIONS FOR SOIL SUMMARY TABLE



**ATTACHMENT B**

**FIELD DESCRIPTIONS FOR SOIL SUMMARY TABLE**

## FIELD DESCRIPTIONS FOR SOIL

### 1. TEXTURAL TERMS AND PROPORTIONS OF SOIL CONSTITUENTS

Clay	Silty Sand
Silty Clay	Sand
Clayey Silt	Gravelly Sand
Silt	Sandy Gravel
Sandy Silt	Gravel

Where apparent, indicate approximate percentages of each constituent.

Trace (Minor) ~ 0 to 5 percent  
Some ~ 5 to 25 percent  
Abundant (clayey, silty, sandy, gravelly) ~ 25 to 50 percent

### 2. PARTICLE SIZE DISTRIBUTION OR RANGE

(used to modify the textural name and describe the second major constituent)

Very Fine Sand	0.01 to 0.07 mm
Fine Sand	0.07 to 0.4 mm
Medium Sand	0.4 to 2 mm
Coarse Sand	2 to 4mm
Very Coarse Sand	4 to 6mm
Granule	4 to 6mm
Gravels	6 mm to 7.5 cm
Cobbles	7.5 to 30 cm
Boulders	>30 cm

### 3. COLOR (see Munsell Soil Color Chart or GSA rock color chart)

Provide name and code in parentheses.  
Where mottled, describe all colors present; where weathered or oxidized, modify with these colors as well.

### 4. SORTING (use to discuss size distribution when coarser grains predominate)

Well Sorted: ~90 percent of particles in 1 or 2 size classes  
Moderately Sorted: ~90 percent of particles in 3 or 4 size classes  
Poorly Sorted: Unsystematic range of particle sizes; no size class predominates  
Sorting = Spread of range or degree of similarity

### 5. PLASTICITY

Nonplastic: Soil falls apart at any water content (crumbly)  
Slightly Plastic: Soil easily crushed with fingers; a thread can barely be rolled; low dry strength  
Plastic: Soil difficult to crush with fingers; easily rolled thread up to the plastic limit; failure after reaching the plastic limit; medium dry strength.  
Very Plastic: Soil impossible to crush with fingers (highly deformable); threads require much time to reach plastic limit and can be rerolled several times after reaching the plastic limit  
Plastic limit = Boundary between the plastic and semisolid state (an Atterberg limit)

### 6. MOISTURE

Dry Slightly Moist Moist Wet

### 7. DENSITY/CONSISTENCY

#### Density of Granular Soils

Very Loose Dense  
Loose Very Dense  
Moderately Dense

#### Consistency of Cohesive Soils

Very Soft Stiff (firm)  
Soft Very Stiff (firm)  
Moderately Stiff (firm) Hard (tight)

### 8. SOIL STRUCTURE

#### Grade/Uniformity

Structureless (homogeneous) Moderate  
Weak Strong

#### Form

Bedding (describe bed thickness) Imbricated  
Stratified Columnar  
Laminated Prismatic  
Banded Blocky  
Platy Granular

#### Defects in Soil Structure

Slickensides Burrows  
Roots Fissures

Cementation Weathering (type and extent)  
Salts Fresh  
Caliche Depth of weathering  
Hardpan Color

### 9. MINERALOGY/ANGULARITY

(pertinent for coarse-grained constituents, including sand grains)

#### General Terms Specific Terms

Arkosic Feldspar, Quartz  
Felsic (light) K-Feldspar, Quartz, Plagioclase, Feldspar  
Mafic (dark) Augite, Hornblende, Biotite, Pyroxene  
Micaceous Muscovite, Biotite, Phlogopite  
Plutonic Granite, Monzonite, Gabbro  
Volcanic Rhyolite, Latite, Basalt  
Oxidized FeO<sub>2</sub>, Limonite  
Rock Fragments

#### Angularity/Shape

Angular Rounded  
Subangular Flat  
Subrounded Elongated

### 10. DESCRIPTION OF SECOND MAJOR CONSTITUENT IF APPLICABLE (refer to horizon boundaries)

### 11. HORIZON BOUNDARIES

General Terms	Specific Terms
Gradational	Abrupt
Sharp	Diffuse
Erosional	Smooth
Depositional	Wavy
	Irregular
	Broken

### 12. ENVIRONMENT OF DEPOSITION

General Terms	Specific Terms (Deposits)
Fill Material	Point Bar
Alluvium	Overbank
Colluvium	Channel
Detritus	Turbidity
Lateritic	Alluvial Fan
Landfill Material	Eolian
	Marine/Bay
	Lagoonal
	Deltaic

### 13. ADDITIONAL INFORMATION

#### Sample Designations

For soil or groundwater samples collected from borehole, including Hydropunch

#### USCS Soil Type

(If not provided in field form)

#### PID Readings (where taken)

Boreholeheadspace direct sample reading

#### Drilling Information

Drilling rate/progress

#### Terminology

Tight Smooth Chattering

#### Fluid Type/Fluid Loss

Intervals of loss Quantity lost

#### Changes in Drilling Methods

#### Explanation of Downtime

#### Photographic Information

Photo number (!) and description, date, time, photographer

#### Groundwater Information

Initial depth to water  
Stabilized depth to water

#### Miscellaneous Information

Borehole to be converted to monitoring well, weather conditions

### EXAMPLE DESCRIPTIONS

(1) Silty clay, about equal silt/clay, mottled olive (5 YR 5/3) to yellowish brown (10 YR 5/6), nonplastic (crumbly), dry, dense, with 1- to 2-mm granules and a 2- to 5-cm lens of coarse quartz sand and gravel, gravels are 3 to 4 mm, rounded, crystalline hard siltstone, sharp contact with GC below, probable fill material, H<sub>nu</sub>=0.1 (open sample).

(2) Clay or silty clay with abundant gravel (about 50 percent), medium to large pebbles (1 to 2.5 cm), well sorted, subrounded, arkosic; clay/silt hard to distinguish, stained dark gray (10 YR 4/1) to gray (10 YR 5/1) with hydrocarbons, slightly plastic, slightly moist, moderately stiff, uniform, sparse mica or sericite, occasional shell fragments, intertidal marine silts/clays; headspace readings 15-25 ppm; photo #29, stained soils in open split spoon, 10/5/90, 1430, D. West; Sample TP-4 (10-11.5) collected.



## **APPENDIX C FIELD FORMS**

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135 Main St. Suite 1800  
San Francisco, CA 94105  
415-543-4880  
Fax 415-543-5480

**Chain of Custody Record** No. \_\_\_\_\_

Page \_\_\_\_\_ of \_\_\_\_\_

[illegible]

	Name (print)	Company Name	Date	Time
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				
Relinquished by:				
Received by:				

**Turnaround time/remarks:****Fed Ex #:**

**TETRA TECH EM INC.**  
**FIELD INSTRUMENT CALIBRATION LOG**

**Project No.:** \_\_\_\_\_  
**Project Name:** \_\_\_\_\_

[illegible]

## SOIL BORING AND WELL INSTALLATION AND VISUAL CLASSIFICATION LOG

**Bldg./Site:**

**Project Name:**

Boring Number:	Date Started:
Drilling Method: ( <i>Circle one</i> ) HSA Continuous Core/Direct Push/Hand Auger	Date Completed:
Air Rotary/Mud Rotary/Dual Tube Percussion/Sonic/Vacuum	Logged By:
Outer Diameter of Boring:	Drilling Subcontractor:
Inner Diameter of Well Casing:	Driller:
Depth to Water (ft./bgs.)	Location Sketch:

[illegible]



**TETRA TECH EM INC.**

## SOIL BORING AND WELL INSTALLATION AND VISUAL CLASSIFICATION LOG

**DO:**

**Bldg./Site:**

**Project Name:**

[illegible]





Tetra Tech EM Inc.

# Daily Quality Control Report

(Page 1 of 2)

**Project Name:**

**Date:**

**Project Number:**

**Day:**

**Weather:**

**Wind:**

**Temperature:**

**Humidity:**

## Personnel on Site

Field Team Leader:

Subcontractors on Site:

## Equipment on Site

## Work Performed (Including Sampling)

## Quality Control Activities

## Health and Safety Levels and Activities

## Problems Encountered / Corrective Action Taken



Tetra Tech EM Inc.

# Daily Quality Control Report

(Page 2 of 2)

## Deviations from Field Work Plan

## Additional Notes

## Anticipated Activities for Tomorrow

**Distribution:**

**Submitted By:**

\_\_\_\_\_  
**Signature**

\_\_\_\_\_  
**Date**

# Corrective Action Request Form

(Page 1 of 2)



Tetra Tech EM Inc.

Project Name: \_\_\_\_\_

Date: \_\_\_\_\_

Project No.: \_\_\_\_\_

Project Manager: \_\_\_\_\_

Location: \_\_\_\_\_

To (Project Manager): \_\_\_\_\_

From (Audit Team Members): \_\_\_\_\_

Description of Problem:

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Corrective Action Required:

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The above corrective action must be completed by (Date): \_\_\_\_\_

**Acknowledgement of Receipt**

\_\_\_\_\_  
(Signature and Date)

# Corrective Action Request Form

(Page 2 of 2)



Tetra Tech EM Inc.

**Corrective Action Taken:**

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**Project Manager:**

---

(Signature and Date)

**Audit Team Members:**

**Corrective Action *is / is not* satisfactory**

---

(Date and Initial)

**Remarks:**

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---

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**QC Coordinators:**

**Corrective Action *is / is not* satisfactory**

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(Date and Initial)

**Remarks:**

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**cc: Program QA Manager**

## Daily Tailgate Safety Meeting Form

Date: \_\_\_\_\_ Time: \_\_\_\_\_ Job Number: \_\_\_\_\_

Client: \_\_\_\_\_ Site Location: \_\_\_\_\_

Scope of Work: \_\_\_\_\_

### Safety Topics Presented

Planned Field Activities for the Day: \_\_\_\_\_

Protective Clothing / Equipment: \_\_\_\_\_

Chemical Hazards: \_\_\_\_\_

Physical Hazards: \_\_\_\_\_

Special Equipment: \_\_\_\_\_

Decontamination Procedures: \_\_\_\_\_

Other: \_\_\_\_\_

Emergency Procedures: \_\_\_\_\_

Hospital: \_\_\_\_\_ Phone: \_\_\_\_\_ Ambulance Phone: \_\_\_\_\_

Hospital Address and Route: \_\_\_\_\_

Employee Questions / Comments: \_\_\_\_\_

### Attendees

Name (Printed)	Signature
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

### Meeting Conducted By:

Name (Printed) / Signature

Name (Printed) / Signature

Site Safety Coordinator

Project Field Manager

**APPENDIX D**  
**PROJECT-REQUIRED REPORTING LIMITS**

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**TABLE D-1: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS (PRRL) AND SCREENING CRITERIA, SVOCs METHOD 8270C, SW-846**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

Compound	Marine Chronic AWQC (µg/L) <sup>a</sup>	Freshwater Chronic AWQC (µg/L) <sup>a</sup>	Water PRRL (µg/L) <sup>b</sup>	Water PRRL Below Most Conservative AWQC ?
Acenaphthene	710	520	10	Yes
Acenaphthylene	<b>300</b>	NA	10	Yes
Anthracene	<b>300</b>	NA	10	Yes
Benzo(a)anthracene	<b>300</b>	NA	10	Yes
Benzo(a)pyrene	<b>300</b>	NA	10	Yes
Benzo(b)fluoranthene	<b>300</b>	NA	10	Yes
Benzo(g,h,i)perylene	<b>300</b>	NA	10	Yes
Benzo(k)fluoranthene	<b>300</b>	NA	10	Yes
Bis(2-chloroethoxy)methane	NA	NA	10	NA
Bis(2-chloroethyl)ether	NA	122	10	NA
Bis(2-chloroisopropyl)ether	NA	NA	10	NA
Bis(2-ethylhexyl)phthalate	NA	NA	10	NA
4-Bromophenyl-phenylether	NA	122	10	NA
Butylbenzylphthalate	<b>2,944</b>	3	10	No <sup>b</sup>
Carbazole	NA	NA	10	NA
4-Chloro-3-methylphenol	NA	NA	10	NA
4-Chloroaniline	NA	NA	10	NA
2-Chloronaphthalene	<b>7.5</b>	<b>1600</b>	10	No <sup>b</sup>
2-Chlorophenol	<b>29,700</b>	<b>2000</b>	10	Yes
4-Chlorophenyl-phenylether	NA	NA	10	NA
Chrysene	<b>300</b>	NA	10	Yes
Dibenz(a,h)anthracene	<b>300</b>	NA	10	Yes
Dibenzofuran	NA	NA	10	NA
1,2-Dichlorobenzene	129	763	10	Yes
1,3-Dichlorobenzene	129	763	10	Yes
1,4-Dichlorobenzene	129	763	10	Yes
3,3'-Dichlorobenzidine	NA	NA	30	NA
2,4-Dichlorophenol	NA	365	10	NA
Diethylphthalate	NA	3	10	NA
2,4-Dimethylphenol	NA	<b>2120</b>	10	NA
Dimethylphthalate	<b>2,944</b>	3	10	No <sup>b</sup>
Di-n-butylphthalate	NA	NA	10	NA
4,6-Dinitro-2-Methylphenol	NA	NA	50	NA
2,4-Dinitrophenol	<b>4,850</b>	<b>230</b>	50	Yes
2,4-Dinitrotoluene	<b>590</b>	<b>230</b>	10	Yes
2,6-Dinitrotoluene	<b>590</b>	<b>230</b>	10	Yes
Di-n-octylphthalate	<b>2,944</b>	3	10	No <sup>b</sup>

**TABLE D-1: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS (PRRL) AND SCREENING CRITERIA, SVOCS METHOD 8270C, SW-846 (Continued)**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

Compound	Marine Chronic AWQC (µg/L) <sup>a</sup>	Freshwater Chronic AWQC (µg/L) <sup>a</sup>	Water PRRL (µg/L) <sup>b</sup>	Water PRRL Below Most Conservative AWQC ?
Fluoranthene	16	<b>3980</b>	10	Yes
Fluorene	<b>300</b>	NA	10	Yes
Hexachlorobenzene	129	<b>250</b>	10	Yes
Hexachlorobutadiene	<b>32</b>	9.3	10	No <sup>b</sup>
Hexachlorocyclopentadiene	<b>7.0</b>	5.2	10	No <sup>b</sup>
Hexachloroethane	<b>940</b>	540	10	Yes
Indeno(1,2,3-cd)pyrene	<b>300</b>	NA	10	Yes
Isophorone	<b>12,900</b>	<b>117,000</b>	10	Yes
2-Methylnaphthalene	NA	NA	10	NA
2-Methylphenol	NA	NA	10	NA
4-Methylphenol	NA	NA	10	NA
Naphthalene	<b>2,350</b>	620	10	Yes
2-Nitroaniline	NA	NA	50	NA
4-Nitroaniline	NA	NA	30	NA
3-Nitroaniline	NA	NA	50	NA
Nitrobenzene	<b>6,680</b>	<b>27,000</b>	10	Yes
2-Nitrophenol	<b>4,850</b>	150	10	Yes
4-Nitrophenol	<b>4,850</b>	150	10	Yes
N-nitroso-di-n-propylamine	<b>3,300,000</b>	<b>5,850</b>	10	Yes
N-nitrosodiphenylamine	<b>3,300,000</b>	<b>5,850</b>	10	Yes
2,2'-Oxybis(1-chloropropane)	NA	NA	10	NA
Pentachlorophenol	NA	NA	50	NA
Phenanthrene	<b>300</b>	NA	10	Yes
Phenol	<b>5,800</b>	2560	10	Yes
Pyrene	<b>300</b>	NA	10	Yes
1,2,4-Trichlorobenzene	NA	50	10	NA
2,4,5-Trichlorophenol	NA	NA	50	NA
2,4,6-Trichlorophenol	NA	970	10	NA

Notes:

- a Criterion in **bold italics** represent acute rather than chronic AWQC. For these chemicals, chronic AWQC are not available.
- b The listed PRRL reflects the maximum sensitivity of current, routinely used analytical methods. The listed PRRL will be used as the project screening criteria unless reasonable grounds are established for pursuing non-routine methods.
- AWQC Ambient Water Quality Criteria (EPA 2002c)
- µg/L Micrograms per liter
- NA Not available
- PRRL Project-required reporting limit



**TABLE D-2: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS (PRRL) AND SCREENING CRITERIA, SVOCS METHOD 8260B, SW-846**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

Compound	Marine Chronic AWQC (µg/L) <sup>a</sup>	Freshwater Chronic AWQC (µg/L) <sup>a</sup>	Water PRRL (µg/L) <sup>b</sup>	Water PRRL Below Most Conservative AWQC ?
Acetone	NA	NA	5	NA
Benzene	<b>5,100</b>	<b>5,300</b>	0.5	Yes
Bromodichloromethane	6,400	<b>11,000</b>	0.5	Yes
Bromoform	6,400	<b>11,000</b>	0.5	Yes
Bromomethane	6,400	<b>11,000</b>	0.5	Yes
2-Butanone	NA	NA	5	NA
Carbon disulfide	NA	NA	0.5	NA
Carbon tetrachloride	6,400	<b>35,200</b>	0.5	Yes
Chlorobenzene	129	50	0.5	Yes
Chloroethane	NA	NA	0.5	NA
Chloroform	6,400	1,240	0.5	Yes
Chloromethane	6,400	<b>11,000</b>	0.5	Yes
Cis-1,3-Dichloropropene	NA	NA	0.5	NA
Dibromochloromethane	6,400	<b>11,000</b>	0.5	Yes
1,1-Dichloroethane	NA	NA	0.5	NA
1,2-Dichloroethane	<b>113,000</b>	20,000	0.5	Yes
1,1-Dichloroethene	NA	NA	0.5	NA
1,2-dichloroethene (total)	NA	NA	0.5	NA
1,2-dichloropropane	3,040	5,700	0.5	Yes
Ethylbenzene	430	<b>32,000</b>	0.5	Yes
2-Hexanone	NA	NA	5	NA
4-Methyl-2-pentanone	NA	NA	5	NA
Methylene chloride	NA	NA	5	NA
Styrene	NA	NA	0.5	NA
1,1,2,2-Tetrachloroethane	NA	2,400	0.5	NA
Tetrachloroethene	450	NA	0.5	Yes
Toluene	5,000	<b>17,500</b>	0.5	Yes
Trans-1,3-Dichloropropene	NA	244	0.5	NA
1,1,1-Trichloroethane	<b>31,200</b>	<b>18,000</b>	0.5	Yes
1,1,2-Trichloroethane	NA	9,400	0.5	NA
Trichloroethene	NA	NA	0.5	NA
Vinyl acetate	NA	NA	0.5	NA
Vinyl chloride	NA	NA	0.5	NA
Xylene (total)	NA	NA	0.5	NA

## TABLE D-2: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS (PRRL) AND SCREENING CRITERIA, SVOCS METHOD 8260B, SW-846

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

### Notes:

- a Criterion in ***bold italics*** represent acute rather than chronic AWQC. For these chemicals, chronic AWQC are not available.
- b The listed PRRL reflects the maximum sensitivity of current, routinely used analytical methods. The listed PRRL will be used as the project screening criteria unless reasonable grounds are established for pursuing non-routine methods.

AWQC Ambient Water Quality Criteria (EPA 2002c)

µg/L Micrograms per liter

NA Not available

PRRL Project-required reporting limit

**TABLE D-3: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING VALUES FOR METALS METHOD 6010B, SW-846**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

<b>Analyte</b>	<b>Concord Tidal Area Ambient 99<sup>th</sup> Percentile (mg/kg)</b>	<b>Coastal Sediment ER-L<sup>1,2</sup> (mg/kg)</b>	<b>Soil PRRL (mg/kg)<sup>b</sup></b>	<b>Soil PRRL Below Ambient?</b>	<b>Soil PRRL Below ER-L?</b>	<b>Marine Chronic AWQC (µg/L)</b>	<b>Freshwater Chronic AWQC (µg/L)</b>	<b>Water PRRL (µg/L)<sup>b</sup></b>	<b>Water PRRL Below Most Conservative AWQC ?</b>
Aluminum	27,300	NA	10	Yes	NA	NA	NA	200	NA
Antimony	2.2	2	3	Yes	Same	NA	NA	60	NA
Arsenic	27	8.2	0.25	Yes	Yes	36	340	10	Yes
Barium	530	NA	0.5	Yes	NA	NA	NA	200	NA
Beryllium	0.18	NA	0.1	Yes	NA	NA	NA	5	NA
Cadmium	1.90	1.2	0.25	Yes	Yes	9.3	4.26	5	No <sup>b</sup>
Calcium	NA	NA	25	NA	NA	NA	NA	500	NA
Chromium	82.1	81.0	0.5	Yes	Yes	50	16	10	Yes
Cobalt	36	NA	1.0	Yes	NA	NA	NA	50	NA
Copper	81	34	0.5	Yes	Yes	NA	13.44	3.1	Yes
Iron	NA	NA	5	NA	NA	NA	NA	100	NA
Lead	95	46.7	0.15	Yes	Yes	8.1	64.58	3	Yes
Magnesium	NA	NA	25	NA	NA	NA	NA	500	NA
Manganese	1,500	NA	0.5	Yes	NA	NA	NA	15	NA
Mercury	0.32	0.15	0.02	Yes	Yes	0.94	<b>52</b>	0.1	Yes
Molybdenum	6.6	NA	1.0	Yes	NA	NA	NA	20	NA
Nickel	120	20.9	1.0	Yes	Yes	NA	468	8.2	Yes
Potassium	NA	NA	25	NA	NA	NA	NA	500	NA

**TABLE D-3: COMPARISON OF PROJECT-REQUIRED REPORTING LIMITS AND SCREENING VALUES FOR METALS METHOD 6010B, SW-846 (Continued)**

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

Analyte	Concord Tidal Area Ambient 99 <sup>th</sup> Percentile (mg/kg)	Coastal Sediment ER-L <sup>1,2</sup> (mg/kg)	Soil PRRL (mg/kg) <sup>b</sup>	Soil PRRL Below Ambient?	Soil PRRL Below ER-L?	Marine Chronic AWQC (µg/L)	Freshwater Chronic AWQC (µg/L)	Water PRRL (µg/L) <sup>b</sup>	Water PRRL Below Most Conservative AWQC ?
Selenium	NA	NA	0.25	NA	NA	71.0	NA	5	Yes
Silver	NA	1	0.25	Yes	Same	NA	3.45	10	No <sup>b</sup>
Sodium	NA	NA	25	NA	NA	NA	NA	500	NA
Thallium	2.2	NA	0.25	Yes	NA	NA	NA	10	NA
Vanadium	96	NA	0.25	Yes	NA	NA	NA	50	NA
Zinc	264	150	1	Yes	Yes	81.0	117	20	Yes

Notes:

a Criterion in ***bold italics*** represent acute rather than chronic AWQC. For these chemicals, chronic AWQC are not available.

b The listed PRRL reflects the maximum sensitivity of current, routinely used analytical methods. The listed PRRL will be used as the project screening criteria unless reasonable grounds are established for pursuing non-routine methods.

1 Long, E.R., D.D. MacDonald, S.L. Smith and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management. 19: 81-97.

2 Long, E.R. and L.G. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. Technical Memorandum NOS OMA52. National Oceanic and Atmospheric Administration, Seattle, WA.

µg/L Micrograms per liter

mg/kg Milligrams per kilogram

NA Not available

PRRL Project-required detection limit

**APPENDIX E**  
**APPROVED AECRU LABORATORIES**

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# TABLE E-1: TETRA TECH EM INC.-APPROVED AECRU LABORATORIES UNDER BASIC ORDERING AGREEMENT

Additional Remedial Investigation for the Taylor Boulevard Bridge (Site 30) and the Tidal Area Landfill (Site 01), Naval Weapons Station Seal Beach Detachment, Concord

Analytical Group	
Lab Address:	12189 Pennsylvania Street Thornton, CO 80241
Point of Contact:	Joe Egry / Mary Fealey
Phone:	(800) 873-8707 X103/X135
Fax:	(303) 469-5254
Business Size:	SWO
E-mail	<a href="mailto:mfealey@analyticagroup.com">mfealey@analyticagroup.com</a>

Columbia Analytical Services	
Lab Address:	5090 Caterpillar Road Redding, CA 96003
Point of Contact:	Karen Sellers / Howard Boorse
Phone:	(530) 244-5262 / (360) 577-7222
Fax:	(530) 244-4109
Business Size:	LB
E-mail	<a href="mailto:lkennedy@kelso.caslab.com">lkennedy@kelso.caslab.com</a>

EMAX Laboratories Inc.	
Lab Address:	1835 205 <sup>th</sup> Street Torrance, CA 90501
Point of Contact:	Ye Myint / Jim Carter
Phone:	(310) 618-8889 X121/X105
Fax:	(310) 618-0818
Business Size:	SDB/WO
E-mail	<a href="mailto:ymyint@emaxlabs.com">ymyint@emaxlabs.com</a>

Sequoia Analytical	
Lab Address:	1455 McDowell Blvd. North, Suite D Petaluma, CA 94954
Point of Contact:	Michelle Wiita
Phone:	(707) 792-7517
Fax:	(707) 792-0342
Business Size:	LB
E-mail	

Applied Physics and Chemistry Laboratory	
Lab Address:	13760 Magnolia Avenue Chino, CA 91710
Point of Contact:	Dan Dischner / Eric Wendland
Phone:	(909) 590-1828 X203/X104
Fax:	(909) 590-1498
Business Size:	SDB
E-mail	<a href="mailto:marketing@apclab.com">marketing@apclab.com</a>

Curtis and Tompkins, Ltd	
Lab Address:	2323 Fifth Street Berkeley, CA 94710
Point of Contact:	Anna Pajarillo / Mike Pearl
Phone:	(510) 486-0925 X103/ X108
Fax:	(510) 486-0532
Business Size:	SB
E-mail	<a href="mailto:mikep@ctberk.com">mikep@ctberk.com</a>

Laucks Laboratories	
Lab Address:	940 S. Harney Street Seattle, WA 98108
Point of Contact:	Mike Owens / Kathy Kreps
Phone:	(206) 767-5060
Fax:	(206) 767-5063
Business Size:	SB
E-mail	<a href="mailto:KathyK@lauckslabs.com">KathyK@lauckslabs.com</a>

## Notes:

DHS California Department of Health Services  
LB Large business  
SB Small business  
SDB Small disabled business  
SWO Small woman-owned  
WO Woman-owned

**APPENDIX F**  
**DETERMINATION OF TRACE METALS AT WATER QUALITY CRITERIA LEVELS**

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**Method 1669**

**Sampling Ambient Water for Trace Metals at EPA Water Quality  
Criteria Levels**

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**July 1996**

**U.S. Environmental Protection Agency  
Office of Water  
Engineering and Analysis Division (4303)  
401 M Street S.W.  
Washington, D.C. 20460**



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## Acknowledgements

This sampling method was prepared under the direction of William A. Telliard of the Engineering and Analysis Division (EAD) within the U.S. Environmental Agency's (EPA's) Office of Science and Technology (OST). This sampling method was prepared under EPA Contract 68 -C3-0337 by the DynCorp Environmental Programs Division, with assistance from Interface, Inc.

The following researchers contributed to the philosophy behind this sampling method. Their contribution is gratefully acknowledged:

Shier Berman, National Research Council, Ottawa, Ontario, Canada;  
Nicholas Bloom, Frontier Geosciences Inc, Seattle, Washington;  
Eric Crecelius, Battelle Marine Sciences Laboratory, Sequim, Washington;  
Russell Flegal, University of California/Santa Cruz, California;  
Gary Gill, Texas A&M University at Galveston, Texas;  
Carlton Hunt and Dion Lewis, Battelle Ocean Sciences, Duxbury, Massachusetts;  
Carl Watras, Wisconsin Department of Natural Resources, Boulder Junction, Wisconsin

Additional support was provided by Ted Martin of the EPA Office of Research and Development's Environmental Monitoring Systems Laboratory in Cincinnati, Ohio and by Arthur Horowitz of the U.S. Geological Survey.

This version of the method was prepared after observations of sampling teams from the University of California at Santa Cruz, the Wisconsin Department of Natural Resources, the U.S. Geological Survey, and Battelle Ocean Sciences. The assistance of personnel demonstrating the sampling techniques used by these institutions is gratefully acknowledged.

## Disclaimer

This sampling method has been reviewed and approved for publication by the Analytical Methods Staff within the Engineering and Analysis Division of the U.S. Environmental Protection Agency. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

## Further Information

For further information, contact:

W.A. Telliard  
Engineering and Analysis Division (4303)  
U.S. Environmental Protection Agency  
401 M Street, SW  
Washington, DC 20460  
Phone: 202/260-7134  
Fax: 202/260-7185

## Introduction

This sampling method was designed to support water quality monitoring programs authorized under the Clean Water Act. Section 304(a) of the Clean Water Act requires EPA to publish water quality criteria that reflect the latest scientific knowledge concerning the physical fate (e.g., concentration and dispersal) of pollutants, the effects of pollutants on ecological and human health, and the effect of pollutants on biological community diversity, productivity, and stability.

Section 303 of the Clean Water Act requires states to set a water quality standard for each body of water within its boundaries. A state water quality standard consists of a designated use or uses of a waterbody or a segment of a waterbody, the water quality criteria that are necessary to protect the designated use or uses, and an antidegradation policy. These water quality standards serve two purposes: (1) they establish the water quality goals for a specific waterbody, and (2) they are the basis for establishing water quality -based treatment controls and strategies beyond the technology -based controls required by Sections 301(b) and 306 of the Clean Water Act.

In defining water quality standards, the state may use narrative criteria, numeric criteria, or both. However, the 1987 amendments to the Clean Water Act required states to adopt numeric criteria for toxic pollutants (designated in Section 307(a) of the Act) based on EPA Section 304(a) criteria or other scientific data, when the discharge or presence of those toxic pollutants could reasonably be expected to interfere with designated uses.

In some cases, these water quality criteria are as much as 280 times lower than those achievable using existing EPA methods and required to support technology -based permits. Therefore, this sampling method, and the analytical methods referenced in Table 1 of this document, were developed by EPA to specifically address state needs for measuring toxic metals at water quality criteria levels, when such measurements are necessary to protect designated uses in state water quality standards. The latest criteria published by EPA are those listed in the National Toxics Rule (57 *FR* 60848) and the Stay of Federal Water Quality Criteria for Metals (60 *FR* 22228). These rules include water quality criteria for 13 metals, and it is these criteria on which this sampling method and the referenced analytical methods are based.

In developing these methods, EPA found that one of the greatest difficulties in measuring pollutants at these levels was precluding sample contamination during collection, transport, and analysis. The degree of difficulty, however, is highly dependent on the metal and site -specific conditions. This method, therefore, is designed to provide the level of protection necessary to preclude contamination in nearly all situations. It is also designed to provide the procedures necessary to produce reliable results at the lowest possible water quality criteria published by EPA. In recognition of the variety of situations to which this method may be applied, and in recognition of continuing technological advances, the method is performance -based. Alternative procedures may be used, so long as those procedures are demonstrated to yield reliable results.

Requests for additional copies of this method should be directed to:

U.S. EPA NCEPI  
11029 Kenwood Road  
Cincinnati, OH 45242  
513/48978190

Note: This document is intended as guidance only. Use of the terms "must," "may," and "should" are included to mean that EPA believes that these procedures must, may, or should be followed in order to produce the desired results when using this guidance. In addition, the guidance is intended to be performance-based, in that the use of less stringent procedures may be used so long as neither samples nor blanks are contaminated when following those modified procedures. Because the only way to measure the performance of the modified procedures is through the collection and analysis of uncontaminated blank samples in accordance with this guidance and the referenced methods, it is highly recommended that any modifications be thoroughly evaluated and demonstrated to be effective before field samples are collected.

## Method 1669

### Sampling Ambient Water for Determination of Metals at EPA Water Quality Criteria Levels

#### 1.0 Scope and Application

- 1.1 This method is for the collection and filtration of ambient water samples for subsequent determination of total and dissolved metals at the levels listed in Table 1. It is designed to support the implementation of water quality monitoring and permitting programs administered under the Clean Water Act.
- 1.2 This method is applicable to the metals listed below and other metals, metals species, and elements amenable to determination at trace levels.

Analyte	Symbol	Chemical Abstract Services Registry Number (CASRN)
Antimony	(Sb)	7440-36-0
Arsenic	(As)	7440-38-2
Cadmium	(Cd)	7440-43-9
Chromium (III)	Cr <sup>+3</sup>	16065-83-1
Chromium (VI)	Cr <sup>+6</sup>	18540-29-9
Copper	(Cu)	7440-50-8
Lead	(Pb)	7439-92-1
Mercury	(Hg)	7439-97-6
Nickel	(Ni)	7440-02-0
Selenium	(Se)	7782-49-2
Silver	(Ag)	7440-22-4
Thallium	(Tl)	7440-28-0
Zinc	(Zn)	7440-66-6

- 1.3 This method is accompanied by the 1600 series methods listed in Table 1. These methods include the sample handling, analysis, and quality control procedures necessary for reliable determination of trace metals in aqueous samples.
- 1.4 This method is not intended for determination of metals at concentrations normally found in treated and untreated discharges from industrial facilities. Existing regulations (40 *CFR* Parts 400-500) typically limit concentrations in industrial discharges to the mid to high part -per-billion (ppb) range, whereas ambient metals concentrations are normally in the low part -per-trillion (ppt) to low ppb range. This guidance is therefore directed at the collection of samples to be measured at or near the levels listed in Table 1. Actual concentration ranges to which this guidance is applicable will be dependent on the sample matrix, dilution levels, and other laboratory operating conditions.
- 1.5 The ease of contaminating ambient water samples with the metal(s) of interest and interfering substances cannot be overemphasized. This method includes sampling techniques that should maximize the ability of the sampling team to collect samples reliably and eliminate sample contamination. These techniques are given in Section 8.0 and are based on findings of researchers performing trace metals analyses (References 1-9).

- 1.6 Clean and Ultraclean? The terms "clean" and "ultraclean" have been used in other Agency guidance to describe the techniques needed to reduce or eliminate contamination in trace metals determinations. These terms are not used in this sampling method due to a lack of exact definitions. However, the information provided in this method is consistent with summary guidance on clean and ultraclean techniques (Reference 10).
- 1.7 This sampling method follows the EPA Environmental Methods Management Council's "Format for Method Documentation" (Reference 11).
- 1.8 Method 1669 is "performance-based"; i.e., an alternate sampling procedure or technique may be used, so long as neither samples nor blanks are contaminated when following the alternate procedures. Because the only way to measure the performance of the alternate procedures is through the collection and analysis of uncontaminated blank samples in accordance with this guidance and the methods referenced in Table 1, it is highly recommended that any modifications be thoroughly evaluated and demonstrated to be effective before field samples are collected. Section 9.2 provides additional details on the tests and documentation required to support equivalent performance.
- 1.9 For dissolved metal determinations, samples must be filtered through a 0.45  $\mu\text{m}$  capsule filter at the field site. The filtering procedures are described in this method. The filtered samples may be preserved in the field or transported to the laboratory for preservation. Procedures for field preservation are detailed in this sampling method; procedures for laboratory preservation are provided in the methods referenced in Table 1. Preservation requirements are summarized in Table 2.
- 1.10 The procedures in this method are for use only by personnel thoroughly trained in the collection of samples for determination of metals at ambient water quality control levels.

## 2.0 Summary of Method

- 2.1 Before samples are collected, all sampling equipment and sample containers are cleaned in a laboratory or cleaning facility using detergent, mineral acids, and reagent water as described in the methods referenced in Table 1. The laboratory or cleaning facility is responsible for generating an acceptable equipment blank to demonstrate that the sampling equipment and containers are free from trace metals contamination before they are shipped to the field sampling team. An acceptable blank is one that is free from contamination below the minimum level (ML) specified in the referenced analytical method (Section 9.3).
- 2.2 After cleaning, sample containers are filled with weak acid solution, individually double-bagged, and shipped to the sampling site. All sampling equipment is also bagged for storage or shipment.

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**NOTE:** EPA has found that, in some cases, it may be possible to empty the weak acid solution from the bottle immediately prior to transport to the field site. In this case, the bottle should be refilled with reagent water (Section 7.1).

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- 2.3 The laboratory or cleaning facility must prepare a large carboy or other appropriate clean container filled with reagent water (Section 7.1) for use with collection of field blanks during sampling activities. The reagent-water-filled container should be shipped to the field site and handled as all other sample containers and sampling equipment. At least one field blank should be processed per site, or one per every ten samples, whichever is more frequent (Section 9.4). If samples are to be collected for determination of trivalent chromium, the sampling team processes additional QC aliquots are processed as described in Section 9.6.

- 2.4 Upon arrival at the sampling site, one member of the two -person sampling team is designated as "dirty hands"; the second member is designated as "clean hands." All operations involving contact with the sample bottle and transfer of the sample from the sample collection device to the sample bottle are handled by the individual designated as "clean hands." "Dirty hands" is responsible for preparation of the sampler (except the sample container itself), operation of any machinery, and for all other activities that do not involve direct contact with the sample.
- 2.5 All sampling equipment and sample containers used for metals determinations at or near the levels listed in Table 1 must be nonmetallic and free from any material that may contain metals.
- 2.6 Sampling personnel are required to wear clean, nontalc gloves at all times when handling sampling equipment and sample containers.
- 2.7 In addition to processing field blanks at each site, a field duplicate must be collected at each sampling site, or one field duplicate per every 10 samples, whichever is more frequent (Section 9.5). Section 9.0 gives a complete description of quality control requirements.
- 2.8 Sampling
- 2.8.1 Whenever possible, samples are collected facing upstream and upwind to minimize introduction of contamination.
- 2.8.2 Samples may be collected while working from a boat or while on land.
- 2.8.3 Surface samples are collected using a grab sampling technique. The principle of the grab technique is to fill a sample bottle by rapid immersion in water and capping to minimize exposure to airborne particulate matter.
- 2.8.4 Subsurface samples are collected by suction of the sample into an immersed sample bottle or by pumping the sample to the surface.
- 2.9 Samples for dissolved metals are filtered through a 0.45  $\mu\text{m}$  capsule filter at the field site. After filtering, the samples are double -bagged and iced immediately. Sample containers are shipped to the analytical laboratory. The sampling equipment is shipped to the laboratory or cleaning facility for recleaning.
- 2.10 Acid preservation of samples is performed in the field or in the laboratory. Field preservation is necessary for determinations of trivalent chromium. It has also been shown that field preservation can increase sample holding times for hexavalent chromium to 30 days; therefore it is recommended that preservation of samples for hexavalent chromium be performed in the field. For other metals, however, the sampling team may prefer to utilize laboratory preservation of samples to expedite field operations and to minimize the potential for sample contamination.
- 2.11 Sampling activities must be documented through paper or computerized sample tracking systems.

### 3.0 Definitions

- 3.1 Apparatus? Throughout this method, the sample containers, sampling devices, instrumentation, and all other materials and devices used in sample collection, sample processing, and sample analysis activities will be referred to collectively as the Apparatus.
- 3.2 Definitions of other terms are given in the Glossary (Section 15.0) at the end of this method.

## 4.0 Contamination and Interferences

### 4.1 Contamination Problems in Trace Metals Analysis

- 4.1.1 Preventing ambient water samples from becoming contaminated during the sampling and analytical process is the greatest challenge faced in trace metals determinations. In recent years, it has been shown that much of the historical trace metals data collected in ambient water are erroneously high because the concentrations reflect contamination from sampling and analysis rather than ambient levels (Reference 12). Therefore, it is imperative that extreme care be taken to avoid contamination when collecting and analyzing ambient water samples for trace metals.
- 4.1.2 There are numerous routes by which samples may become contaminated. Potential sources of trace metals contamination during sampling include metallic or metal -containing sampling equipment, containers, labware (e.g. talc gloves that contain high levels of zinc), reagents, and deionized water; improperly cleaned and stored equipment, labware, and reagents; and atmospheric inputs such as dirt and dust from automobile exhaust, cigarette smoke, nearby roads, bridges, wires, and poles. Even human contact can be a source of trace metals contamination. For example, it has been demonstrated that dental work (e.g., mercury amalgam fillings) in the mouths of laboratory personnel can contaminate samples that are directly exposed to exhalation (Reference 3).

### 4.2 Contamination Control

- 4.2.1 **Philosophy?** The philosophy behind contamination control is to ensure that any object or substance that contacts the sample is nonmetallic and free from any material that may contain metals of concern.
- 4.2.1.1 The integrity of the results produced cannot be compromised by contamination of samples. Requirements and suggestions for controlling sample contamination are given in this sampling method and in the analytical methods referenced in Table 1.
- 4.2.1.2 Substances in a sample or in the surrounding environment cannot be allowed to contaminate the Apparatus used to collect samples for trace metals measurements. Requirements and suggestions for protecting the Apparatus are given in this sampling method and in the methods referenced in Table 1.
- 4.2.1.3 While contamination control is essential, personnel health and safety remain the highest priority. Requirements and suggestions for personnel safety are given in Section 5 of this sampling method and in the methods referenced in Table 1.
- 4.2.2 **Avoiding contamination?** The best way to control contamination is to completely avoid exposure of the sample and Apparatus to contamination in the first place. Avoiding exposure means performing operations in an area known to be free from contamination. Two of the most important factors in avoiding/reducing sample contamination are (1) an awareness of potential sources of contamination and (2) strict attention to work being performed. Therefore, it is imperative that the procedures described in this method be carried out by well trained, experienced personnel. Documentation of training should be kept on file and readily available for review.
- 4.2.2.1 **Minimize exposure?** The Apparatus that will contact samples or blanks should only be opened or exposed in a clean room, clean bench, glove box, or clean plastic bag,

so that exposure to atmospheric inputs is minimized. When not being used, the Apparatus should be covered with clean plastic wrap, stored in the clean bench or in a plastic box or glove box, or bagged in clean, colorless zip -type bags. Minimizing the time between cleaning and use will also reduce contamination.

4.2.2.2 **Wear gloves?** Sampling personnel must wear clean, nontalc gloves (Section 6.7) during all operations involving handling of the Apparatus, samples, and blanks. Only clean gloves may touch the Apparatus. If another object or substance is touched, the glove(s) must be changed before again handling the Apparatus. If it is even suspected that gloves have become contaminated, work must be halted, the contaminated gloves removed, and a new pair of clean gloves put on. Wearing multiple layers of clean gloves will allow the old pair to be quickly stripped with minimal disruption to the work activity.

4.2.2.3 **Use metal-free Apparatus?** All Apparatus used for metals determinations at the levels listed in Table 1 must be nonmetallic and free of material that may contain metals. When it is not possible to obtain equipment that is completely free of the metal(s) of interest, the sample should not come into direct contact with the equipment.

4.2.2.3.1 **Construction materials?** Only the following materials should come in contact with samples: fluoropolymer (FEP, PTFE), conventional or linear polyethylene, polycarbonate, polysulfone, polypropylene, or ultrapure quartz. PTFE is less desirable than FEP because the sintered material in PTFE may contain contaminants and is susceptible to serious memory effects (Reference 6). Fluoropolymer or glass containers should be used for samples that will be analyzed for mercury because mercury vapors can diffuse in or out of other materials, resulting either in contamination or low-biased results (Reference 3). Metal must not be used under any circumstance. Regardless of construction, all materials that will directly or indirectly contact the sample must be cleaned using the procedures described in the referenced analytical methods (see Table 1) and must be known to be clean and metal -free before proceeding.

4.2.2.3.2 **The following materials have been found to contain trace metals and must not be used to hold liquids that come in contact with the sample or must not contact the sample, unless these materials have been shown to be free of the metals of interest at the desired level:** Pyrex, Kimax, methacrylate, polyvinylchloride, nylon, and Vycor (Reference 6). In addition, highly colored plastics, paper cap liners, pigments used to mark increments on plastics, and rubber all contain trace levels of metals and must be avoided (Reference 13).

4.2.2.3.3 **Serialization?** Serial numbers should be indelibly marked or etched on each piece of Apparatus so that contamination can be traced, and logbooks should be maintained to track the sample from the container through the sampling process to shipment to the laboratory. Chain-of-custody procedures may also be used if warranted so that contamination can be traced to particular handling procedures or lab personnel.



- 4.2.2.3.4 The Apparatus should be clean when the sampling team receives it. If there are any indications that the Apparatus is not clean (e.g., a ripped storage bag), an assessment of the likelihood of contamination must be made. Sampling must not proceed if it is possible that the Apparatus is contaminated. If the Apparatus is contaminated, it must be returned to the laboratory or cleaning facility for proper cleaning before any sampling activity resumes.
- 4.2.2.3.5 Details for recleaning the Apparatus between collection of individual samples are provided in Section 10.0.
- 4.2.2.4 Avoid sources of contamination ? Avoid contamination by being aware of potential sources and routes of contamination.
- 4.2.2.4.1 Contamination by carryover ? Contamination may occur when a sample containing low concentrations of metals is processed immediately after a sample containing relatively high concentrations of these metals. At sites where more than one sample will be collected, the sample known or expected to contain the lowest concentration of metals should be collected first with the sample containing the highest levels collected last (Section 8.1.4). This will help minimize carryover of metals from high - concentration samples to low - concentration samples. If the sampling team does not have prior knowledge of the waterbody, or when necessary, the sample collection system should be rinsed with dilute acid and reagent water between samples and followed by collection of a field blank (Section 10.3).
- 4.2.2.4.2 Contamination by samples ? Significant contamination of the Apparatus may result when untreated effluents, in -process waters, landfill leachates, and other samples containing mid - to high-level concentrations of inorganic substances are processed. As stated in Section 1.0, this sampling method is not intended for application to these samples, and samples containing high concentrations of metals must not be collected, processed, or shipped at the same time as samples being collected for trace metals determinations.
- 4.2.2.4.3 Contamination by indirect contact ? Apparatus that may not directly contact samples may still be a source of contamination. For example, clean tubing placed in a dirty plastic bag may pick up contamination from the bag and subsequently transfer the contamination to the sample. Therefore, it is imperative that every piece of the Apparatus that is directly or indirectly used in the collection of ambient water samples be cleaned as specified in the analytical method(s) referenced in Table 1.
- 4.2.2.4.4 Contamination by airborne particulate matter ? Less obvious substances capable of contaminating samples include airborne particles. Samples may be contaminated by airborne dust, dirt, particulate matter, or vapors from automobile exhaust; cigarette smoke; nearby corroded or rusted bridges, pipes, poles, or wires; nearby roads; and even human breath (Section 4.1.2). Whenever

possible, the sampling activity should occur as far as possible from sources of airborne contamination (Section 8.1.3). Areas where nearby soil is bare and subject to wind erosion should be avoided.

- 4.3 Interferences ?Interferences resulting from samples will vary considerably from source to source, depending on the diversity of the site being sampled. If a sample is suspected of containing substances that may interfere in the determination of trace metals, sufficient sample should be collected to allow the laboratory to identify and overcome interference problems.

## 5.0 Safety

- 5.1 The toxicity or carcinogenicity of the chemicals used in this method has not been precisely determined; however, these chemicals should be treated as a potential health hazard. Exposure should be reduced to the lowest possible level. Sampling teams are responsible for maintaining a current awareness file of OSHA regulations for the safe handling of the chemicals specified in this method. A reference file of Material Safety Data Sheets should also be made available to all personnel involved in sampling. It is also suggested that the organization responsible perform personal hygiene monitoring of each sampling team member who uses this method and that the results of this monitoring be made available to the member.
- 5.2 Operating in and around waterbodies carries the inherent risk of drowning. Life jackets must be worn when operating from a boat, when sampling in more than a few feet of water, or when sampling in swift currents.
- 5.3 Collecting samples in cold weather, especially around cold water bodies, carries the risk of hypothermia, and collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing for protection in cold weather and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.

## 6.0 Apparatus and Materials

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**NOTE:** Brand names, suppliers, and part numbers are for illustration only and no endorsement is implied. Equivalent performance may be achieved using apparatus and materials other than those specified here. Meeting the performance requirements of this method is the responsibility of the sampling team and laboratory.

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- 6.1 All sampling equipment and sample containers must be precleaned in a laboratory or cleaning facility, as described in the methods referenced in Table 1, before they are shipped to the field site. Performance criteria for equipment cleaning is described in the referenced methods. To minimize difficulties in sampling, the equipment should be packaged and arranged to minimize field preparation.
- 6.2 Materials such as gloves (Section 6.7), storage bags (Section 6.8), and plastic wrap (Section 6.9), may be used new without additional cleaning unless the results of the equipment blank pinpoint any of these materials as a source of contamination. In this case, either a different supplier must be obtained or the materials must be cleaned.
- 6.3 Sample Bottles ?Fluoropolymer (FEP, PTFE), conventional or linear polyethylene, polycarbonate, or polypropylene; 500 mL or 1 L with lids. If mercury is a target analyte, fluoropolymer or glass bottles should be used. Refer to the methods referenced in Table 1 for bottle cleaning procedures.

- 6.3.1 Cleaned sample bottles should be filled with 0.1% HCl (v/v). In some cases, it may be possible to empty the weak acid solution from the sample bottle immediately prior to transport to the field site. In this case, the bottle should be refilled with reagent water (Section 7.1).
- 6.3.2 Whenever possible, sampling devices should be cleaned and prepared for field use in a class 100 clean room. Preparation of the devices in the field should be done within the glove bag (Section 6.6). Regardless of design, sampling devices must be constructed of nonmetallic material (Section 4.2.2.3.1) and free from material that contains metals. Fluoropolymer or other material shown not to adsorb or contribute mercury must be used if mercury is a target analyte; otherwise, polyethylene, polycarbonate, or polypropylene are acceptable. Commercially available sampling devices may be used provided that any metallic or metal-containing parts are replaced with parts constructed of nonmetallic material.
- 6.4 Surface Sampling Devices ? Surface samples are collected using a grab sampling technique. Samples may be collected manually by direct submersion of the bottle into the water or by using a grab sampling device. Examples of grab samplers are shown in Figures 1 and 2 and may be used at sites where depth profiling is neither practical nor necessary.
- 6.4.1 The grab sampler in Figure 1 consists of a heavy fluoropolymer collar fastened to the end of a 2-m-long polyethylene pole, which serves to remove the sampling personnel from the immediate vicinity of the sampling point. The collar holds the sample bottle. A fluoropolymer closing mechanism, threaded onto the bottle, enables the sampler to open and close the bottle under water, thereby avoiding surface microlayer contamination (Reference 14). Polyethylene, polycarbonate, and polypropylene are also acceptable construction materials unless mercury is a target analyte. Assembly of the cleaned sampling device is as follows (refer to Figure 1):
- 6.4.1.1 Thread the pull cord (with the closing mechanism attached) through the guides and secure the pull ring with a simple knot. Screw a sample bottle onto the closing device and insert the bottle into the collar. Cock the closing plate so that the plate is pushed away from the operator.
- 6.4.1.2 The cleaned and assembled sampling device should be stored in a double layer of large, clean zip-type polyethylene bags or wrapped in two layers of clean polyethylene wrap if it will not be used immediately.
- 6.4.2 An alternate grab sampler design is shown in Figure 2. This grab sampler is used for discrete water samples and is constructed so that a capped clean bottle can be submerged, the cap removed, sample collected, and bottle recapped at a selected depth. This device eliminates sample contact with conventional samplers (e.g., Niskin bottles), thereby reducing the risk of extraneous contamination. Because a fresh bottle is used for each sample, carryover from previous samples is eliminated (Reference 15).
- 6.5 Subsurface Sampling Devices ? Subsurface sample collection may be appropriate in lakes and sluggish deep river environments or where depth profiling is determined to be necessary. Subsurface samples are collected by pumping the sample into a sample bottle. Examples of subsurface collection systems include the jar system device shown in Figure 3 and described in Section 6.5.1 or the continuous-flow apparatus shown in Figure 4 and described in Section 6.5.2.
- 6.5.1 Jar sampler (Reference 14)? The jar sampler (Figure 3) is comprised of a heavy fluoropolymer 1-L jar with a fluoropolymer lid equipped with two 1/4 in. fluoropolymer

fittings. Sample enters the jar through a short length of fluoropolymer tubing inserted into one fitting. Sample is pulled into the jar by pumping on fluoropolymer tubing attached to the other fitting. A thick fluoropolymer plate supports the jar and provides attachment points for a fluoropolymer safety line and fluoropolymer torpedo counterweight.

6.5.1.1 Advantages of the jar sampler for depth sampling are (1) all wetted surfaces are fluoropolymer and can be rigorously cleaned; (2) the sample is collected into a sample jar from which the sample is readily recovered, and the jar can be easily recleaned; (3) the suction device (a peristaltic or rotary vacuum pump, Section 6.15) is located in the boat, isolated from the sampling jar; (4) the sampling jar can be continuously flushed with sample, at sampling depth, to equilibrate the system; and (5) the sample does not travel through long lengths of tubing that are more difficult to clean and keep clean (Reference 14). In addition, the device is designed to eliminate atmospheric contact with the sample during collection.

6.5.1.2 To assemble the cleaned jar sampler, screw the torpedo weight onto the machined bolt attached to the support plate of the jar sampler. Attach a section of the 1/4 in. o.d. tubing to the jar by inserting the tubing into the fitting on the lid and pushing down into the jar until approximately 8 cm from the bottom. Tighten the fitting nut securely. Attach the solid safety line to the jar sampler using a bowline knot to the loop affixed to the support plate.

6.5.1.3 For the tubing connecting the pump to the sampler, tubing lengths of up to 12 m have been used successfully (Reference 14).

6.5.2 Continuous-flow sampler (References 16-17)? This sampling system, shown in Figure 4, consists of a peristaltic or submersible pump and one or more lengths of precleaned fluoropolymer or styrene/ethylene/butylene/silicone (SEBS) tubing. A filter is added to the sampling train when sampling for dissolved metals.

6.5.2.1 Advantages of this sampling system include (1) all wetted surfaces are fluoropolymer or SEBS and can be readily cleaned; (2) the suction device is located in the boat, isolated from the sample bottle; (3) the sample does not travel through long lengths of tubing that are difficult to clean and keep clean; and (4) in-line filtration is possible, minimizing field handling requirements for dissolved metals samples.

6.5.2.2 The sampling team assembles the system in the field as described in Section 8.2.8. System components include an optional polyethylene pole to remove sampling personnel from the immediate vicinity of the sampling point and the pump, tubing, filter, and filter holder listed in Sections 6.14 and 6.15.

6.6 Field-Portable Glove Bag? I2R, Model R-37-37H (nontalc), or equivalent. Alternately, a portable glove box may be constructed with a nonmetallic (PVC pipe or other suitable material) frame and a frame cover made of an inexpensive, disposable, nonmetallic material (e.g., a thin-walled polyethylene bag) (Reference 7).

6.7 Gloves? Clean, nontalc polyethylene, latex, vinyl, or PVC; various lengths. Shoulder-length gloves are needed if samples are to be collected by direct submersion of the sample bottle into the water or when sampling for mercury.

6.7.1 Gloves, shoulder-length polyethylene? Associated Bag Co., Milwaukee, WI, 66-3-301, or equivalent.

- 6.7.2 Gloves, PVC?Fisher Scientific Part No. 11-394-100B, or equivalent.
- 6.8 Storage Bags?Clean, zip-type, nonvented, colorless polyethylene (various sizes).
- 6.9 Plastic Wrap?Clean, colorless polyethylene.
- 6.10 Cooler?Clean, nonmetallic, with white interior for shipping samples.
- 6.11 Ice or Chemical Refrigerant Packs ?To keep samples chilled in the cooler during shipment.
- 6.12 Wind Suit?Pamida, or equivalent.

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**NOTE:** *This equipment is necessary only for collection of metals, such as mercury, that are known to have elevated atmospheric concentrations.*

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- 6.12.1 An unlined, long -sleeved wind suit consisting of pants and jacket and constructed of nylon or other synthetic fiber is worn when sampling for mercury to prevent mercury adsorbed onto cotton or other clothing materials from contaminating samples.
- 6.12.2 Washing and drying?The wind suit is washed by itself or with other wind suits only in a home or commercial washing machine and dried in a clothes dryer. The clothes dryer must be thoroughly vacuumed, including the lint filter, to remove all traces of lint before drying. After drying, the wind suit is folded and stored in a clean polyethylene bag for shipment to the sample site.
- 6.13 Boat
  - 6.13.1 For most situations (e.g., most metals under most conditions), the use of an existing, available boat is acceptable. A flat-bottom, Boston Whaler -type boat is preferred because sampling materials can be stored with reduced chance of tipping.
    - 6.13.1.1 Immediately before use, the boat should be washed with water from the sampling site away from any sampling points to remove any dust or dirt accumulation.
    - 6.13.1.2 Samples should be collected upstream of boat movement.
  - 6.13.2 For mercury, and for situations in which the presence of contaminants cannot otherwise be controlled below detectable levels, the following equipment and precautions may be necessary:
    - 6.13.2.1 A metal-free (e.g., fiberglass) boat, along with wooden or fiberglass oars. Gasoline- or diesel-fueled boat motors should be avoided when possible because the exhaust can be a source of contamination. If the body of water is large enough to require use of a boat motor, the engine should be shut off at a distance far enough from the sampling point to avoid contamination, and the sampling team should manually propel the boat to the sampling point. Samples should be collected upstream of boat movement.
    - 6.13.2.2 Before first use, the boat should be cleaned and stored in an area that minimizes exposure to dust and atmospheric particles. For example,

cleaned boats should not be stored in an area that would allow exposure to automobile exhaust or industrial pollution.

6.13.2.3 The boat should be frequently visually inspected for possible contamination.

6.13.2.4 After sampling, the boat should be returned to the laboratory or cleaning facility, cleaned as necessary, and stored away from any sources of contamination until next use.

6.14 Filtration Apparatus? Required when collecting samples for dissolved metals determinations.

6.14.1 Filter? 0.45  $\mu\text{m}$ , 15 mm diameter or larger, tortuous -path capsule filters (Reference 18), Gelman Supor 12175, or equivalent.

6.14.2 Filter holder? For mounting filter to the gunwale of the boat. Rod or pipe made from plastic material and mounted with plastic clamps.

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**NOTE:** A filter holder may not be required if one or a few samples are to be collected. For these cases, it may only be necessary to attach the filter to the outlet of the tubing connected to the pump.

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6.15 Pump and Pump Apparatus? Required for use with the jar sampling system (Section 6.5.1) or the continuous-flow system (Section 6.5.2). Peristaltic pump; 115 V a.c., 12 V d.c., internal battery, variable-speed, single-head, Cole-Parmer, portable, "Masterflex L/S," Catalog No. H-07570-10 drive with Quick Load pump head, Catalog No. H-07021-24, or equivalent.

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**NOTE:** Equivalent pumps may include rotary vacuum, submersible, or other pumps free from metals and suitable to meet the site-specific depth sampling needs.

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6.15.1 Cleaning? Peristaltic pump modules do not require cleaning. However, nearly all peristaltic pumps contain a metal head and metal controls. Touching the head or controls necessitates changing of gloves before touching the Apparatus. If a submersible pump is used, a large volume of sample should be pumped to clean the stainless steel shaft (hidden behind the impeller) that comes in contact with the sample. Pumps with metal impellers should not be used.

6.15.2 Tubing? For use with peristaltic pump. SEBS resin, approximately 3/8 in. i.d. by approximately 3 ft, Cole-Parmer size 18, Cat. No. G-06464-18, or approximately 1/4 in. i.d., Cole-Parmer size 17, Catalog No. G-06464-17, or equivalent. Tubing is cleaned by soaking in 5-10% HCl solution for 8-24 hours, rinsing with reagent water in a clean bench in a clean room, and drying in the clean bench by purging with mercury-free air or nitrogen. After drying, the tubing is double-bagged in clear polyethylene bags, serialized with a unique number, and stored until use.

6.15.3 Tubing? For connection to peristaltic pump tubing. Fluoropolymer, 3/8 or 1/4 in. o.d., in lengths as required to reach the point of sampling. If sampling will be at some depth from the end of a boom extended from a boat, sufficient tubing to extend to the end of the boom and to the depth will be required. Cleaning of the fluoropolymer can be the same as cleaning the tubing for the rotary vacuum pump (Section 6.15.1.2). If necessary, more aggressive cleaning (e.g., concentrated nitric acid) may be used.

6.15.4 Batteries to operate submersible pump? 12 V, 2.6 amp, gel cell, YUASA NP2.6-12, or equivalent. A 2 amp fuse connected at the positive battery terminal is strongly recommended

to prevent short circuits from overheating the battery. A 12 V, lead -acid automobile or marine battery may be more suitable for extensive pumping.

- 6.15.5 Tubing connectors? Appropriately sized PVC, clear polyethylene, or fluoropolymer "barbed " straight connectors cleaned as the tubing above. Used to connect multiple lengths of tubing.
- 6.16 Carboy? For collection and storage of dilute waste acids used to store bottles.
- 6.17 Apparatus? For field preservation of aliquots for trivalent chromium determinations.
  - 6.17.1 Fluoropolymer forceps? 1 L fluoropolymer jar, and 30 mL fluoropolymer vials with screw - caps (one vial per sample and blank). It is recommended that 1 mL of ultrapure nitric acid (Section 7.3) be added to each vial prior to transport to the field to simplify field handling activities (See Section 8.4.4.6).
  - 6.17.2 Filters? 0.4  $\mu$ m, 47 mm polycarbonate Nuclepore (or equivalent). Filters are cleaned as follows. Fill a 1 L fluoropolymer jar approximately two -thirds full with 1 N nitric acid. Using fluoropolymer forceps, place individual filters in the fluoropolymer jar. Allow the filters to soak for 48 hours. Discard the acid, and rinse five times with reagent water. Fill the jar with reagent water, and soak the filters for 24 hours. Remove the filters when ready for use, and using fluoropolymer forceps, place them on the filter apparatus (Section 6.17.3).
  - 6.17.3 Vacuum filtration apparatus? Millipore 47 mm size, or equivalent, vacuum pump and power source (and extension cords, if necessary) to operate the pump.
  - 6.17.4 Eppendorf auto pipet and colorless pipet tips (100 -1000  $\mu$ L)
  - 6.17.5 Wrist-action shaker? Burrel or equivalent.
  - 6.17.6 Fluoropolymer wash bottles ? One filled with reagent water (Section 7.1) and one filled with high- purity 10% HCl (Section 7.4.4), for use in rinsing forceps and pipet tips.

## 7.0 Reagents and Standards

- 7.1 Reagent Water? Water in which the analytes of interest and potentially interfering substances are not detected at the Method Detection Limit (MDL) of the analytical method used for analysis of samples. Prepared by distillation, deionization, reverse osmosis, anodic/cathodic stripping voltammetry, or other techniques that remove the metal(s) and potential interferent(s). A large carboy or other appropriate container filled with reagent water must be available for the collection of field blanks.
- 7.2 Nitric Acid? Dilute, trace-metal grade, shipped with sampling kit for cleaning equipment between samples.
- 7.3 Sodium Hydroxide? Concentrated, 50% solution for use when field -preserving samples for hexavalent chromium determinations (Section 8.4.5).
- 7.4 Reagents? For field-processing aliquots for trivalent chromium determinations
  - 7.4.1 Nitric Acid, Ultrapure? For use when field -preserving samples for trivalent chromium determinations (Sections 6.17 and 8.4.4).

- 7.4.2 Ammonium Iron (II) Sulfate Solution (0.01M) ?Used to prepare the chromium (III) extraction solution (Section 7.4.3) necessary for field preservation of samples for trivalent chromium (Section 8.4.4). Prepare the ammonium iron (II) sulfate solution by adding 3.92 g ammonium iron (II) sulfate (ultrapure grade) to a 1 L volumetric flask. Bring to volume with reagent water. Store in a clean polyethylene bottle.
- 7.4.3 Chromium (III) extraction solution ?For use when field-preserving samples for trivalent chromium determinations (Section 8.4.4). Prepare this solution by adding 100 mL of ammonium iron (II) sulfate solution (Section 7.4.2) to a 125 mL polyethylene bottle. Adjust pH to 8 with approximately 2 mL of ammonium hydroxide solution. Cap and shake on a wrist-action shaker for 24 hours. This iron (III) hydroxide solution is stable for 30 days.
- 7.4.4 Hydrochloric acid ?High-purity, 10% solution, shipped with sampling kit in fluoropolymer wash bottles for cleaning trivalent chromium sample preservation equipment between samples.
- 7.4.5 Chromium stock standard solution (1000 µg/mL)?Prepared by adding 3.1 g anhydrous chromium chloride to a 1 L flask and diluting to volume with 1% hydrochloric acid. Store in polyethylene bottle. A commercially available standard solution may be substituted.
- 7.4.6 Standard chromium spike solution (1000 µg/L)?Used to spike sample aliquots for matrix spike/matrix spike duplicate (MS/MSD) analysis and to prepare ongoing precision and recovery standards. Prepared by spiking 1 mL of the chromium stock standard solution (Section 7.4.5) into a 1 L flask. Dilute to volume with 1% HCl. Store in a polyethylene bottle.
- 7.4.7 Ongoing precision and recovery (OPR) standard (25 µg/L)?Prepared by spiking 2.5 mL of the standard chromium spike solution (Section 7.4.6) into a 100 mL flask. Dilute to volume with 1% HCl. One OPR is required for every 10 samples.

## 8.0 Sample Collection, Filtration, and Handling

### 8.1 Site Selection

- 8.1.1 Selection of a representative site for surface water sampling is based on many factors including: study objectives, water use, point source discharges, non-point source discharges, tributaries, changes in stream characteristics, types of stream bed, stream depth, turbulence, and the presence of structures (bridges, dams, etc.). When collecting samples to determine ambient levels of trace metals, the presence of potential sources of metal contamination are of extreme importance in site selection.
- 8.1.2 Ideally, the selected sampling site will exhibit a high degree of cross-sectional homogeneity. It may be possible to use previously collected data to identify locations for samples that are well mixed or are vertically or horizontally stratified. Since mixing is principally governed by turbulence and water velocity, the selection of a site immediately downstream of a riffle area will ensure good vertical mixing. Horizontal mixing occurs in constrictions in the channel. In the absence of turbulent areas, the selection of a site that is clear of immediate point sources, such as industrial effluents, is preferred for the collection of ambient water samples (Reference 19).
- 8.1.3 To minimize contamination from trace metals in the atmosphere, ambient water samples should be collected from sites that are as far as possible (e.g., at least several hundred feet)



from any metal supports, bridges, wires or poles. Similarly, samples should be collected as far as possible from regularly or heavily traveled roads. If it is not possible to avoid collection near roadways, it is advisable to study traffic patterns and plan sampling events during lowest traffic flow (Reference 7).

- 8.1.4 The sampling activity should be planned to collect samples known or suspected to contain the lowest concentrations of trace metals first, finishing with the samples known or suspected to contain the highest concentrations. For example, if samples are collected from a flowing river or stream near an industrial or municipal discharge, the up stream sample should be collected first, the downstream sample collected second, and the sample nearest the discharge collected last. If the concentrations of pollutants is not known and cannot be estimated, it is necessary to use precleaned sampling equipment at each sampling location.
- 8.2 Sample Collection Procedure? Before collecting ambient water samples, consideration should be given to the type of sample to be collected, the amount of sample needed, and the devices to be used (grab, surface, or subsurface samplers). Sufficient sample volume should be collected to allow for necessary quality control analyses, such as matrix spike/matrix spike duplicate analyses.
  - 8.2.1 Four sampling procedures are described:
    - 8.2.1.1 Section 8.2.5 describes a procedure for collecting samples directly into the sample container. This procedure is the simplest and provides the least potential for contamination because it requires the least amount of equipment and handling.
    - 8.2.1.2 Section 8.2.6 describes a procedure for using a grab sampling device to collect samples.
    - 8.2.1.3 Section 8.2.7 describes a procedure for depth sampling with a jar sampler. The size of sample container used is dependent on the amount of sample needed by the analytical laboratory.
    - 8.2.1.4 Section 8.2.8 describes a procedure for continuous -flow sampling using a submersible or peristaltic pump.
  - 8.2.2 The sampling team should ideally approach the site from down current and downwind to prevent contamination of the sample by particles sloughing off the boat or equipment. If it is not possible to approach from both, the site should be approached from down current if sampling from a boat or approached from downwind if sampling on foot. When sampling from a boat, the bow of the boat should be oriented into the current (the boat will be pointed upstream). All sampling activity should occur from the bow.
 

If the samples are being collected from a boat, it is recommended that the sampling team create a stable workstation by arranging the cooler or shipping container as a work table on the upwind side of the boat, covering this worktable and the upwind gunnel with plastic wrap or a plastic tablecloth, and draping the wrap or cloth over the gunnel. If necessary, duct tape is used to hold the wrap or cloth in place.
  - 8.2.3 All operations involving contact with the sample bottle and with transfer of the sample from the sample collection device to the sample bottle (if the sample is not directly collected in the bottle) are handled by the individual designated as "clean hands." "Dirty hands" is responsible for all activities that do not involve direct contact with the sample.

Although the duties of "clean hands" and "dirty hands" would appear to be a logical separation of responsibilities, in fact, the completion of the entire protocol may require a good deal of coordination and practice. For example, "dirty hands" must open the box or cooler containing the sample bottle and unzip the outer bag; clean hands must reach into the outer bag, open the inner bag, remove the bottle, collect the sample, replace the bottle lid, put the bottle back into the inner bag, and zip the inner bag. "Dirty hands" must close the outer bag and place it in a cooler.

To minimize unnecessary confusion, it is recommended that a third team member be available to complete the necessary sample documentation (e.g., to document sampling location, time, sample number, etc). Otherwise, "dirty hands" must perform the sample documentation activity (Reference 7).

- 8.2.4 Extreme care must be taken during all sampling operations to minimize exposure of the sample to human, atmospheric, and other sources of contamination. Care must be taken to avoid breathing directly on the sample, and whenever possible, the sample bottle should be opened, filled, and closed while submerged.
- 8.2.5 Manual collection of surface samples directly into the sample bottle.
  - 8.2.5.1 At the site, all sampling personnel must put on clean gloves (Section 6.7) before commencing sample collection activity, with "clean hands" donning shoulder-length gloves. If samples are to be analyzed for mercury, the sampling team must also put their precleaned wind suits on at this time. Note that "clean hands" should put on the shoulder-length polyethylene gloves (Section 6.7.1) and both "clean hands" and "dirty hands" should put on the PVC gloves (Section 6.7.2).
  - 8.2.5.2 "Dirty hands" must open the cooler or storage container, remove the double-bagged sample bottle from storage, and unzip the outer bag.
  - 8.2.5.3 Next, "clean hands" opens the inside bag containing the sample bottle, removes the bottle, and reseals the inside bag. "Dirty hands" then reseals the outer bag.
  - 8.2.5.4 "Clean hands" unscrews the cap and, while holding the cap upside down, discards the dilute acid solution from the bottle into a carboy for wastes (Section 6.16) or discards the reagent water directly into the water body.
  - 8.2.5.5 "Clean hands" then submerges the sample bottle, and allows the bottle to partially fill with sample. "Clean hands" screws the cap on the bottle, shakes the bottle several times, and empties the rinsate away from the site. After two more rinsings, "clean hands" holds the bottle under water and allows bottle to fill with sample. After the bottle has filled (i.e., when no more bubbles appear), and while the bottle is still inverted so that the mouth of the bottle is underwater, "clean hands" replaces the cap of the bottle. In this way, the sample has never contacted the air.
  - 8.2.5.6 Once the bottle lid has been replaced, "dirty hands" reopens the outer plastic bag, and "clean hands" opens the inside bag, places the bottle inside it, and zips the inner bag.
  - 8.2.5.7 "Dirty hands" zips the outer bag.

- 8.2.5.8 Documentation? After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.
- 8.2.5.9 If the sample is to be analyzed for dissolved metals, it is filtered in accordance with the procedure described in Section 8.3.
- 8.2.6 Sample collection with grab sampling device ?The following steps detail sample collection using the grab sampling device shown in Figure 1 and described in Section 6.4.1. The procedure is indicative of the "clean hands/dirty hands" technique that must be used with alternative grab sampling devices such as that shown in Figure 2 and described in Section 6.4.2.
- 8.2.6.1 The sampling team puts on gloves (and wind suits, if applicable). Ideally, a sample bottle will have been preattached to the sampling device in the class 100 clean room at the laboratory. If it is necessary to attach a bottle to the device in the field, "clean hands" performs this operation, described in Section 6.4.2, inside the field -portable glove bag (Section 6.6).
- 8.2.6.2 "Dirty hands" removes the sampling device from its storage container and opens the outer polyethylene bag.
- 8.2.6.3 "Clean hands" opens the inside polyethylene bag and removes the sampling device.
- 8.2.6.4 "Clean hands" changes gloves.
- 8.2.6.5 "Dirty hands" submerges the sampling device to the desired depth and pulls the fluoropolymer pull cord to bring the seal plate into the middle position so that water can enter the bottle.
- 8.2.6.6 When the bottle is full (i.e., when no more bubbles appear), "dirty hands" pulls the fluoropolymer cord to the final stop position to seal off the sample and removes the sampling device from the water.
- 8.2.6.7 "Dirty hands" returns the sampling device to its large inner plastic bag, "clean hands" pulls the bottle out of the collar, unscrews the bottle from the sealing device, and caps the bottle. "Clean hands" and "dirty hands" then return the bottle to its double - bagged storage as described in Sections 8.2.5.6 through 8.2.5.7.
- 8.2.6.8 Closing mechanism ? "Clean hands" removes the closing mechanism from the body of the grab sampler, rinses the device with reagent water (Section 7.1), places it inside a new clean plastic bag, zips the bag, and places the bag inside an outer bag held by "dirty hands." "Dirty hands" zips the outer bag and places the double - bagged closing mechanism in the equipment storage box.
- 8.2.6.9 Sampling device? "Clean hands" seals the large inside bag containing the collar, pole, and cord and places the bag into a large outer bag held by "dirty hands." "Dirty hands" seals the outside bag and places the double - bagged sampling device into the equipment storage box.

- 8.2.6.10 Documentation? After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.
- 8.2.6.11 If the sample is to be analyzed for dissolved metals, it is filtered in accordance with the procedures described in Section 8.3.
- 8.2.7 Depth sampling using a jar sampling device (Figure 3 and Section 6.5.1)
- 8.2.7.1 The sampling team puts on gloves (and wind suits, if applicable) and handles bottles as with manual collection (Sections 8.2.5.1 through 8.2.5.4 and 8.2.5.6 through 8.2.5.7).
- 8.2.7.2 "Dirty hands" removes the jar sampling device from its storage container and opens the outer polyethylene bag.
- 8.2.7.3 "Clean hands" opens the inside polyethylene bag and removes the jar sampling apparatus. Ideally, the sampling device will have been preassembled in a class 100 clean room at the laboratory. If, however, it is necessary to assemble the device in the field, "clean hands" must perform this operation, described in Section 6.5.2, inside a field-portable glove bag (Section 6.6).
- 8.2.7.4 While "dirty hands" is holding the jar sampling apparatus, "clean hands" connects the pump to the to the 1/4 in. o.d. flush line.
- 8.2.7.5 "Dirty hands" lowers the weighted sampler to the desired depth.
- 8.2.7.6 "Dirty hands" turns on the pump allowing a large volume (>2 L) of water to pass through the system.
- 8.2.7.7 After stopping the pump, "dirty hands" pulls up the line, tubing, and device and places them into either a field-portable glove bag or a large, clean plastic bag as they emerge.
- 8.2.7.8 Both "clean hands" and "dirty hands" change gloves.
- 8.2.7.9 Using the technique described in Sections 8.2.5.2 through 8.2.5.4, the sampling team removes a sample bottle from storage, and "clean hands" places the bottle into the glove bag.
- 8.2.7.10 "Clean hands" tips the sampling jar and dispenses the sample through the short length of fluoropolymer tubing into the sample bottle.
- 8.2.7.11 Once the bottle is filled, "clean hands" replaces the cap of the bottle, returns the bottle to the inside polyethylene bag, and zips the bag. "Clean hands" returns the zipped bag to the outside polyethylene bag held by "dirty hands."
- 8.2.7.12 "Dirty hands" zips the outside bag. If the sample is to be analyzed for dissolved metals, it is filtered as described in Section 8.3.

8.2.7.13 Documentation? After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

8.2.8 Continuous-flow sampling (Figure 4 and Section 6.5.2) ? The continuous-flow sampling system uses peristaltic pump (Section 6.1.5) to pump sample to the boat or to shore through the SEBS-resin or PTFE tubing.

8.2.8.1 Before putting on wind suits or gloves, the sampling team removes the bags containing the pump (Section 6.15), SEBS-resin tubing (Section 6.15.2), batteries (Section 6.15.4), gloves (Section 6.7), plastic wrap (Section 6.9), wind suits (Section 6.12), and, if samples are to be filtered, the filtration apparatus (Section 6.14) from the coolers or storage containers in which they are packed.

8.2.8.2 "Clean hands" and "dirty hands" put on the wind suits and PVC gloves (Section 6.7.2).

8.2.8.3 "Dirty hands" removes the pump from its storage bag, and opens the bag containing the SEBS-resin tubing.

8.2.8.4 "Clean hands" installs the tubing while "dirty hands" holds the pump. "Clean hands" immerses the inlet end of the tubing in the sample stream.

8.2.8.5 Both "clean hands" and "dirty hands" change gloves. "Clean hands" also puts on shoulder length polyethylene gloves (Section 6.7.1).

8.2.8.6 "Dirty hands" turns the pump on and allows the pump to run for 5-10 minutes or longer to purge the pump and tubing.

8.2.8.7 If the sample is to be filtered, "clean hands" installs the filter at the end of the tubing, and "dirty hands" sets up the filter holder on the gunwale as shown in Figure 4.

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**NOTE:** *The filtration apparatus is not attached until immediately before sampling to prevent buildup of particulates from clogging the filter.*

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8.2.8.8 The sample is collected by rinsing the sample bottle and cap three times and collecting the sample from the flowing stream.

8.2.8.9 Documentation? After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

8.3 Sample Filtration? The filtration procedure described below is used for samples collected using the manual (Section 8.2.5), grab (Section 8.2.6), or jar (Section 8.2.7) collection systems (Reference 7). In-line filtration using the continuous-flow approach is described in Section 8.2.8.7. Because of the risk of contamination, it is recommended that samples for mercury be shipped unfiltered by overnight courier and filtered when received at the laboratory.

8.3.1 Set up the filtration system inside the glove bag, using the shortest piece of pump tubing as is practicable. Place the peristaltic pump immediately outside of the glove bag and poke a small hole in the glove bag for passage of the tubing. Also, attach a short length of tubing to the outlet of the capsule filter.

- 8.3.2 "Clean hands" removes the water sample from the inner storage bag using the technique described in Sections 8.2.5.2 through 8.2.5.4 and places the sample inside the glove bag. "Clean hands" also places two clean empty sample bottles, a bottle containing reagent water, and a bottle for waste in the glove bag.
- 8.3.3 "Clean hands" removes the lid of the reagent water bottle and places the end of the pump tubing in the bottle.
- 8.3.4 "Dirty hands" starts the pump and passes approximately 200 mL of reagent water through the tubing and filter into the waste bottle. "Clean hands" then moves the outlet tubing to a clean bottle and collects the remaining reagent water as a blank. "Dirty hands" stops the pump.
- 8.3.5 "Clean hands" removes the lid of the sample bottle and places the intake end of the tubing in the bottle.
- 8.3.6 "Dirty hands" starts the pump and passes approximately 50 mL through the tubing and filter into the remaining clean sample bottle and then stops the pump. "Clean hands" uses the filtrate to rinse the bottle, discards the waste sample, and returns the outlet tube to the sample bottle.
- 8.3.7 "Dirty hands" starts the pump and the remaining sample is processed through the filter and collected in the sample bottle. If preservation is required, the sample is acidified at this point (Section 8.4).
- 8.3.8 "Clean hands" replaces the lid on the bottle, returns the bottle to the inside bag, and zips the bag. "Clean hands" then places the zipped bag into the outer bag held by "dirty hands."
- 8.3.9 "Dirty hands" zips the outer bag, and places the double -bagged sample bottle into a clean, ice-filled cooler for immediate shipment to the laboratory.

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**NOTE:** *It is not advisable to reclean and reuse filters. The difficulty and risk associated with failing to properly clean these devices far outweighs the cost of purchasing a new filter.*

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#### 8.4 Preservation

- 8.4.1 Field preservation is not necessary for dissolved metals, except for trivalent and hexavalent chromium, provided that the sample is preserved in the laboratory and allowed to stand for at least two days to allow the metals adsorbed to the container walls to redissolve. Field preservation is advised for hexavalent chromium in order to provide sample stability for up to 30 days. Mercury samples should be shipped by overnight courier and preserved when received at the laboratory.
- 8.4.2 If field preservation is required, preservation must be performed in the glove bag or in a designated clean area, with gloved hands, as rapidly as possible to preclude particulates from contaminating the sample. For preservation of trivalent chromium, the glove bag or designated clean area must be large enough to accommodate the vacuum filtration apparatus (Section 6.17.3), and an area should be available for setting up the wrist -action shaker (Section 6.17.5). It is also advisable to set up a work area that contains a "clean" cooler for storage of clean equipment, a "dirty" cooler for storage of "dirty" equipment, and a third cooler to store samples for shipment to the laboratory.

- 8.4.3 Preservation of aliquots for metals other than trivalent and hexavalent chromium ?Using a disposable, precleaned, plastic pipet, add 5 mL of a 10% solution of ultrapure nitric acid in reagent water per liter of sample. This will be sufficient to preserve a neutral sample to pH <2.
- 8.4.4 Preservation of aliquots for trivalent chromium (References 8 -9).
- 8.4.4.1 Decant 100 mL of the sample into a clean polyethylene bottle.
- 8.4.4.2 Clean an Eppendorf pipet by pipeting 1 mL of 10% HCl (Section 7.4.4) followed by 1 mL of reagent water into an acid waste container. Use the rinsed pipet to add 1 mL of chromium (III) extraction solution (Section 7.4.3) to each sample and blank.
- 8.4.4.3 Cap each bottle tightly, place in a clean polyethylene bag, and shake on a wrist action shaker (Section 6.17.5) for one hour.
- 8.4.4.4 Vacuum-filter the precipitate through a 0.4  $\mu$ m pretreated filter membrane (Section 6.17.2), using fluoropolymer forceps (Section 6.17.1) to handle the membrane, and a 47 mm vacuum filtration apparatus with a precleaned filter holder (Section 6.17.3). After all sample has filtered, rinse the inside of the filter holder with approximately 15 mL of reagent water.
- 8.4.4.5 Using the fluoropolymer forceps, fold the membrane in half and then in quarters, taking care to avoid touching the side containing the filtrate to any surface. (Folding is done while the membrane is sitting on the filter holder and allows easy placement of the membrane into the sample vial). Transfer the filter to a 30 mL fluoropolymer vial. If the fluoropolymer vial was not pre-equipped with the ultrapure nitric acid (Section 7.4.1), rinse the pipet by drawing and discharging 1 mL of 10% HCl followed by 1 mL of reagent water into a waste container, and add 1 mL of ultrapure nitric acid to the sample vial.
- 8.4.4.6 Cap the vial and double -bag it for shipment to the laboratory.
- 8.4.4.7 Repeat Steps 8.4.4.4-8.4.4.6 for each sample, rinsing the fluoropolymer forceps and the pipet with 10% high -purity HCl followed by reagent water between samples.
- 8.4.5 Preservation of aliquots for hexavalent chromium (Reference 20).
- 8.4.5.1 Decant 125 mL of sample into a clean polyethylene bottle.
- 8.4.5.2 Prepare an Eppendorf pipet by pipeting 1 mL of 10% HCl (Section 7.4.4) followed by 1 mL of reagent water into an acid waste container. Use the rinsed pipet to add 1 mL NaOH to each 125 mL sample and blank aliquot.
- 8.4.5.3 Cap the vial(s) and double -bag for shipment to the laboratory.

## 9.0 Quality Assurance/Quality Control

- 9.1 The sampling team shall employ a strict quality assurance/ quality control (QA/QC) program. The minimum requirements of this program include the collection of equipment blanks, field blanks, and field replicates. It is also desirable to include blind QC samples as part of the program. If samples will be processed for trivalent chromium determinations, the sampling team shall also prepare method blank, OPR, and MS/MSD samples as described in Section 9.6.
- 9.2 The sampling team is permitted to modify the sampling techniques described in this method to improve performance or reduce sampling costs, provided that reliable analyses of samples are obtained and that samples and blanks are not contaminated. Each time a modification is made to the procedures, the sampling team is required to demonstrate that the modification does not result in contamination of field and equipment blanks. The requirements for modification are given in Sections 9.3 and 9.4. Because the acceptability of a modification is based on the results obtained with the modification, the sampling team must work with an analytical laboratory capable of making trace metals determinations to demonstrate equivalence.
- 9.3 Equipment Blanks
- 9.3.1 Before using any sampling equipment at a given site, the laboratory or equipment cleaning contractor is required to generate equipment blanks to demonstrate that the equipment is free from contamination. Two types of equipment blanks are required: bottle blanks and sampling equipment blanks.
- 9.3.2 Equipment blanks must be run on all equipment that will be used in the field. If, for example, samples are to be collected using both a grab sampling device and the jar sampling device, then an equipment blank must be run on both pieces of equipment.
- 9.3.3 Equipment blanks are generated in the laboratory or at the equipment cleaning contractor's facility by processing reagent water through the equipment using the same procedures that are used in the field (Section 8.0). Therefore, the "clean hands/dirty hands " technique used during field sampling should be followed when preparing equipment blanks at the laboratory or cleaning facility. In addition, training programs must require sampling personnel to collect a clean equipment blank before performing on -site field activities.
- 9.3.4 Detailed procedures for collecting equipment blanks are given in the analytical methods referenced in Table 1.
- 9.3.5 The equipment blank must be analyzed using the procedures detailed in the referenced analytical method (see Table 1). If any metal(s) of interest or any potentially interfering substance is detected in the equipment blank at the minimum level specified in the referenced method, the source of contamination/interference must be identified and removed. The equipment must be demonstrated to be free from the metal(s) of interest before the equipment may be used in the field.
- 9.4 Field Blank
- 9.4.1 To demonstrate that sample contamination has not occurred during field sampling and sample processing, at least one field blank must be generated for every 10 samples that are collected at a given site. Field blanks are collected before sample collection.



- 9.4.2 Field blanks are generated by filling a large carboy or other appropriate container with reagent water (Section 7.1) in the laboratory, transporting the filled container to the sampling site, processing the water through each of the sample processing steps and equipment (e.g., tubing, sampling devices, filters, etc.) that will be used in the field, collecting the field blank in one of the sample bottles, and shipping the bottle to the laboratory for analysis in accordance with the method(s) referenced in Table 1. For example, manual grab sampler field blanks are collected by directly submerging a sample bottle into the water, filling the bottle, and capping. Subsurface sampler field blanks are collected by immersing the tubing into the water and pumping water into a sample container.
- 9.4.3 Filter the field blanks using the procedures described in Section 8.3.
- 9.4.4 If it is necessary to acid clean the sampling equipment between samples (Section 10.0), a field blank should be collected after the cleaning procedures but before the next sample is collected.
- 9.4.5 If trivalent chromium aliquots are processed, a separate field blank must be collected and processed through the sample preparation steps given in Sections 8.4.4.1 through 8.4.4.6.
- 9.5 Field Duplicate
  - 9.5.1 To assess the precision of the field sampling and analytical processes, at least one field duplicate sample must be collected for every 10 samples that are collected at a given site.
  - 9.5.2 The field duplicate is collected either by splitting a larger volume into two aliquots in the glove box, by using a sampler with dual inlets that allows simultaneous collection of two samples, or by collecting two samples in rapid succession.
  - 9.5.3 Field duplicates for dissolved metals determinations must be processed using the procedures in Section 8.3. Field duplicates for trivalent chromium must be processed through the sample preparation steps given in Sections 8.4.4.1 through 8.4.4.6.
- 9.6 Additional QC for Collection of Trivalent Chromium Aliquots
  - 9.6.1 Method blank? The sampling team must prepare one method blank for every ten or fewer field samples. Each method blank is prepared using the steps in Sections 8.4.4.1 through 8.4.4.6 on a 100 mL aliquot of reagent water (Section 7.1). Do not use the procedures in Section 8.3 to process the method blank through the 0.45  $\mu$ m filter (Section 6.14.1), even if samples are being collected for dissolved metals determinations.
  - 9.6.2 Ongoing precision and recovery (OPR) ? The sampling team must prepare one OPR for every ten or fewer field samples. The OPR is prepared using the steps in Sections 8.4.4.1 through 8.4.4.6 on the OPR standard (Section 7.4.7). Do not use the procedures in Section 8.3 to process the OPR through the 0.45  $\mu$ m filter (Section 6.14.1), even if samples are being collected for dissolved metals determinations.
  - 9.6.3 MS/MSD? The sampling team must prepare one MS and one MSD for every ten or fewer field samples.
    - 9.6.3.1 If, through historical data, the background concentration of the sample can be estimated, the MS and MSD samples should be spiked at a level of one to five times the background concentration.

9.6.3.2 For samples in which the background concentration is unknown, the MS and MSD samples should be spiked at a concentration of 25 µg/L.

9.6.3.3 Prepare the matrix spike sample by spiking a 100 -mL aliquot of sample with 2.5 mL of the standard chromium spike solution (Section 7.4.6), and processing the MS through the steps in Sections 8.4.4.1 through 8.4.4.6.

9.6.3.4 Prepare the matrix spike duplicate sample by spiking a second 100 -mL aliquot of the same sample with 2.5 mL of the standard chromium spike solution, and processing the MSD through the steps in Sections 8.4.4.1 through 8.4.4.6.

9.6.3.5 If field samples are collected for dissolved metals determinations, it is necessary to process an MS and an MSD through the 0.45 µm filter as described in Section 8.3.

## 10.0 Recleaning the Apparatus Between Samples

10.1 Sampling activity should be planned so that samples known or suspected to contain the lowest concentrations of trace metals are collected first with the samples known or suspected to contain the highest concentrations of trace metals collected last. In this manner, cleaning of the sampling equipment between samples is unnecessary. If it is not possible to plan sampling activity in this manner, dedicated sampling equipment should be provided for each sampling event.

10.2 If samples are collected from adjacent sites (e.g., immediately upstream or downstream), rinsing of the sampling Apparatus with water that is to be sampled should be sufficient.

10.3 If it is necessary to cross a gradient (i.e., going from a high -concentration sample to a low -concentration sample), such as might occur when collecting at a second site, the following procedure may be used to clean the sampling equipment between samples:

10.3.1 In the glove bag, and using the "clean hands/dirty hands" procedure in Section 8.2.5, process the dilute nitric acid solution (Section 7.2) through the Apparatus.

10.3.2 Dump the spent dilute acid in the waste carboy or in the waterbody away from the sampling point.

10.3.3 Process 1 L of reagent water through the Apparatus to rinse the equipment and discard the spent water.

10.3.4 Collect a field blank as described in Section 9.4.

10.3.5 Rinse the Apparatus with copious amounts of the ambient water sample and proceed with sample collection.

10.4 Procedures for recleaning trivalent chromium preservation equipment between samples are described in Section 8.4.4.

## 11.0 Method Performance

Samples were collected in the Great Lakes during September - October 1994 using the procedures in this sampling method.

## 12.0 Pollution Prevention

- 12.1 The only materials used in this method that could be considered pollutants are the acids used in the cleaning of the Apparatus, the boat, and related materials. These acids are used in dilute solutions in small amounts and pose little threat to the environment when managed properly.
- 12.2 Cleaning solutions containing acids should be prepared in volumes consistent with use to minimize the disposal of excessive volumes of acid.
- 12.3 To the extent possible, the Apparatus used to collect samples should be cleaned and reused to minimize the generation of solid waste.

## 13.0 Waste Management

- 13.1 It is the sampling team's responsibility to comply with all federal, state, and local regulations governing waste management, particularly the discharge regulations, hazardous waste identification rules, and land disposal restrictions; and to protect the air, water, and land by minimizing and controlling all releases from field operations.
- 13.2 For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* and *Less is Better? Laboratory Chemical Management for Waste Reduction*, available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington, DC 20036.

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## 15.0 Glossary of Definitions and Purposes

These definitions and purposes are specific to this sampling method but have been conformed to common usage as much as possible.

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- 15.1 Ambient Water? Waters in the natural environment (e.g., rivers, lakes, streams, and other receiving waters), as opposed to effluent discharges.
- 15.2 Apparatus? The sample container and other containers, filters, filter holders, labware, tubing, pipets, and other materials and devices used for sample collection or sample preparation, and that will contact samples, blanks, or analytical standards.
- 15.3 Equipment Blank? An aliquot of reagent water that is subjected in the laboratory to all aspects of sample collection and analysis, including contact with all sampling devices and apparatus. The purpose of the equipment blank is to determine if the sampling devices and apparatus for sample collection have been adequately cleaned before they are shipped to the field site. An acceptable equipment blank must be achieved before the sampling devices and Apparatus are used for sample collection.
- 15.4 Field Blank? An aliquot of reagent water that is placed in a sample container in the laboratory, shipped to the field, and treated as a sample in all respects, including contact with the sampling devices and exposure to sampling site conditions, filtration, storage, preservation, and all analytical procedures. The purpose of the field blank is to determine whether the field or sample transporting procedures and environments have contaminated the sample.
- 15.5 Field Duplicates (FD1 and FD2)? Two identical aliquots of a sample collected in separate sample bottles at the same time and place under identical circumstances using a dual inlet sampler or by splitting a larger aliquot and treated exactly the same throughout field and laboratory procedures. Analyses of FD1 and FD2 give a measure of the precision associated with sample collection, preservation, and storage, as well as with laboratory procedures.
- 15.6 Matrix Spike (MS) and Matrix Spike Duplicate (MSD)? Aliquots of an environmental sample to which known quantities of the analytes are added in the laboratory. The MS and MSD are analyzed exactly like a sample. Their purpose is to quantify the bias and precision caused by the sample matrix. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS and MSD corrected for background concentrations.
- 15.7 May? This action, activity, or procedural step is optional.
- 15.8 May Not? This action, activity, or procedural step is prohibited.
- 15.9 Minimum Level (ML)? The lowest level at which the entire analytical system gives a recognizable signal and acceptable calibration point (Reference 21).
- 15.10 Must? This action, activity, or procedural step is required.
- 15.11 Reagent Water? Water demonstrated to be free from the metal(s) of interest and potentially interfering substances at the MDL for that metal in the referenced method or additional method.
- 15.12 Should? This action, activity, or procedural step is suggested but not required.
- 15.13 Trace-Metal Grade? Reagents that have been demonstrated to be free from the metal(s) of interest at the method detection limit (MDL) of the analytical method to be used for determination of this metal(s).

The term "trace-metal grade" has been used in place of "reagent grade" or "reagent" because acids and other materials labeled "reagent grade" have been shown to contain concentrations of metals that will interfere in the determination of trace metals at levels listed in Table 1.

**TABLE 1. ANALYTICAL METHODS, METALS, AND CONCENTRATION LEVELS APPLICABLE TO METHOD 1669**

Method	Technique	Metal	MDL (mg/L) <sup>1</sup>	ML (mg/L) <sup>2</sup>
1631	Oxidation/Purge & Trap/CVAFS	Mercury	0.0002	0.0005
1632	Hydride AA	Arsenic	0.003	0.01
1636	Ion Chromatography	Hexavalent Chromium	0.23	0.5
1637	CC/STGFAA	Cadmium	0.0075	0.02
		Lead	0.036	0.1
1638	ICP/MS	Antimony	0.0097	0.02
		Cadmium	0.013	0.1
		Copper	0.087	0.2
		Lead	0.015	0.05
		Nickel	0.33	1
		Selenium	0.45	1
		Silver	0.029	0.1
		Thallium	0.0079	0.02
		Zinc	0.14	0.5
1639	STGFAA	Antimony	1.9	5
		Cadmium	0.023	0.05
		Trivalent Chromium	0.10	0.2
		Nickel	0.65	2
		Selenium	0.83	2
		Zinc	0.14	0.5
1640	CC/ICP/MS	Cadmium	0.0024	0.01
		Copper	0.024	0.1
		Lead	0.0081	0.02
		Nickel	0.029	0.1

<sup>1</sup> Method Detection Limit as determined by 40 CFR Part 136, Appendix B.

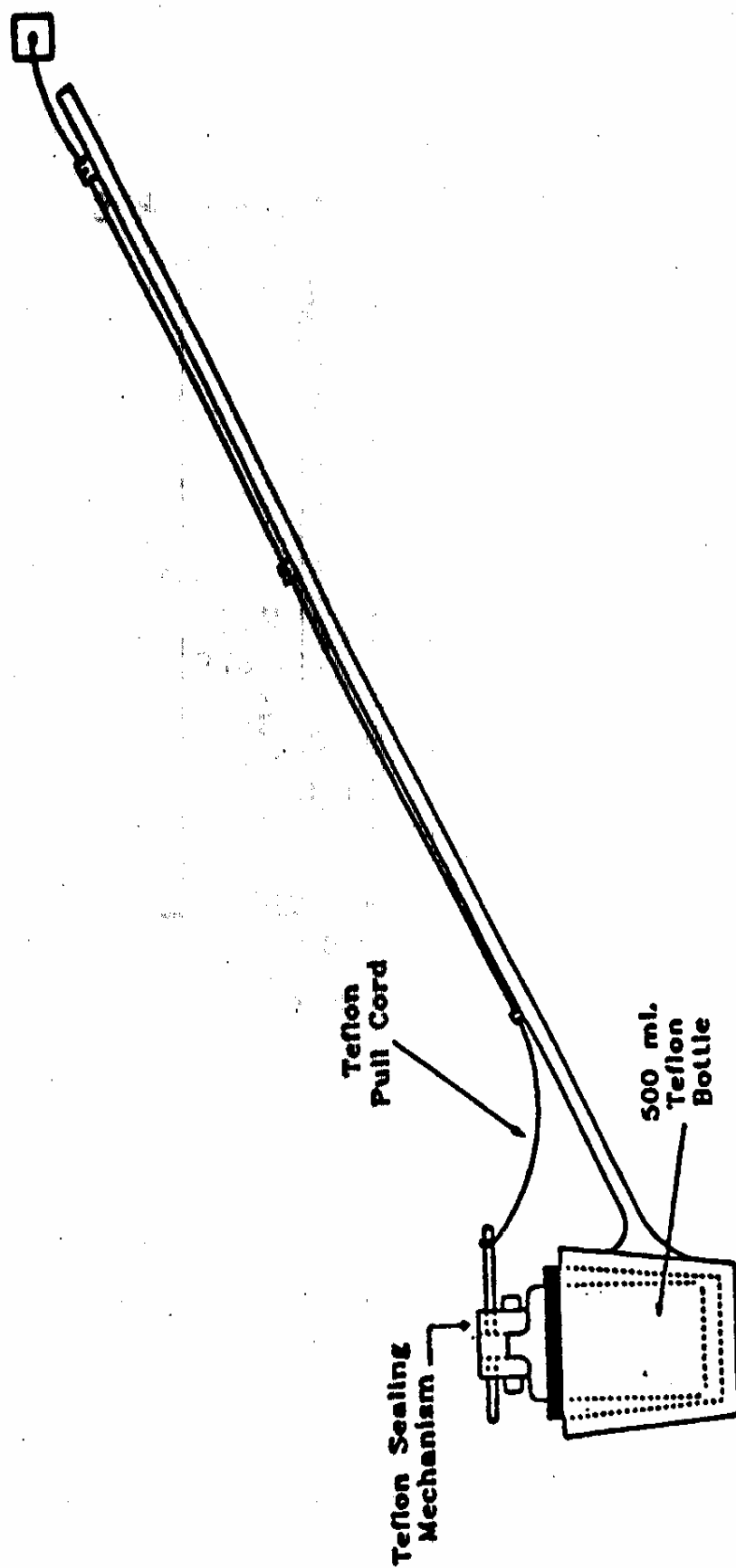
<sup>2</sup> Minimum Level (ML) calculated by multiplying laboratory -determined MDL by 3.18 and rounding result to nearest multiple of 1, 2, 5, 10, 20, 50, etc., in accordance with procedures used by EAD and described in the EPA *Draft National Guidance for the Permitting, Monitoring, and Enforcement of Water Quality-Based Effluent Limitations Set Below Analytical Detection/Quantitation Levels*, March 22, 1994.

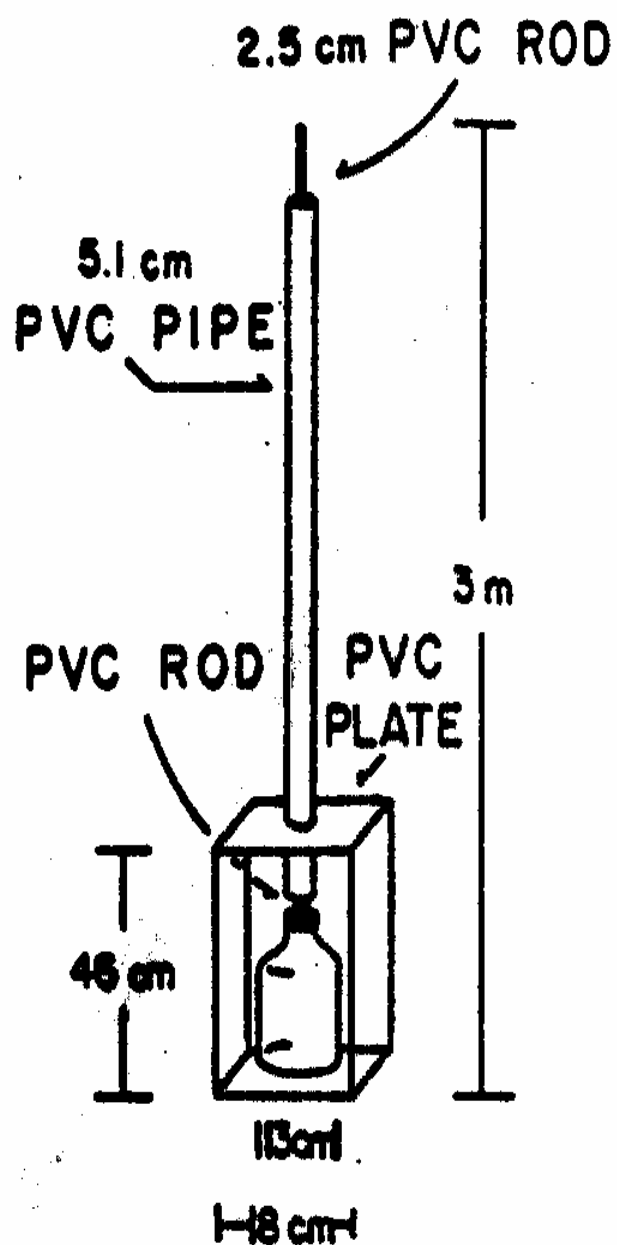
**TABLE 2. ANALYTES, PRESERVATION REQUIREMENTS, AND CONTAINERS**

<b>Metal</b>	<b>Preservation Requirements</b>	<b>Acceptable Containers</b>
Antimony Arsenic Cadmium Copper Lead Nickel Selenium Silver Thallium Zinc	Add 5 mL of 10% $\text{HNO}_3$ to 1-L sample; preserve on-site or immediately upon laboratory receipt.	500 mL or 1 L fluoropolymer, conventional or linear polyethylene, polycarbonate, or polypropylene containers with lid
Chromium (III)	Add 1 mL chromium (III) extraction solution to 100 mL aliquot, vacuum filter through 0.4 $\mu\text{m}$ membrane, add 1 mL 10% $\text{HNO}_3$ ; preserve on-site immediately after collection.	500 mL or 1 L fluoropolymer, conventional or linear polyethylene, polycarbonate, or polypropylene containers with lid
Chromium (IV)	Add 50% NaOH; preserve immediately after sample collection.	500 mL or 1 L fluoropolymer, conventional or linear polyethylene, polycarbonate, or polypropylene containers with lid
Mercury	Total: Add 0.5% high-purity HCl or 0.5% BrCl to pH < 2; Total & Methyl: Add 0.5% high-purity HCl; preserve on-site or immediately upon laboratory receipt	Fluoropolymer or borosilicate glass bottles with fluoropolymer or fluoropolymer-lined caps

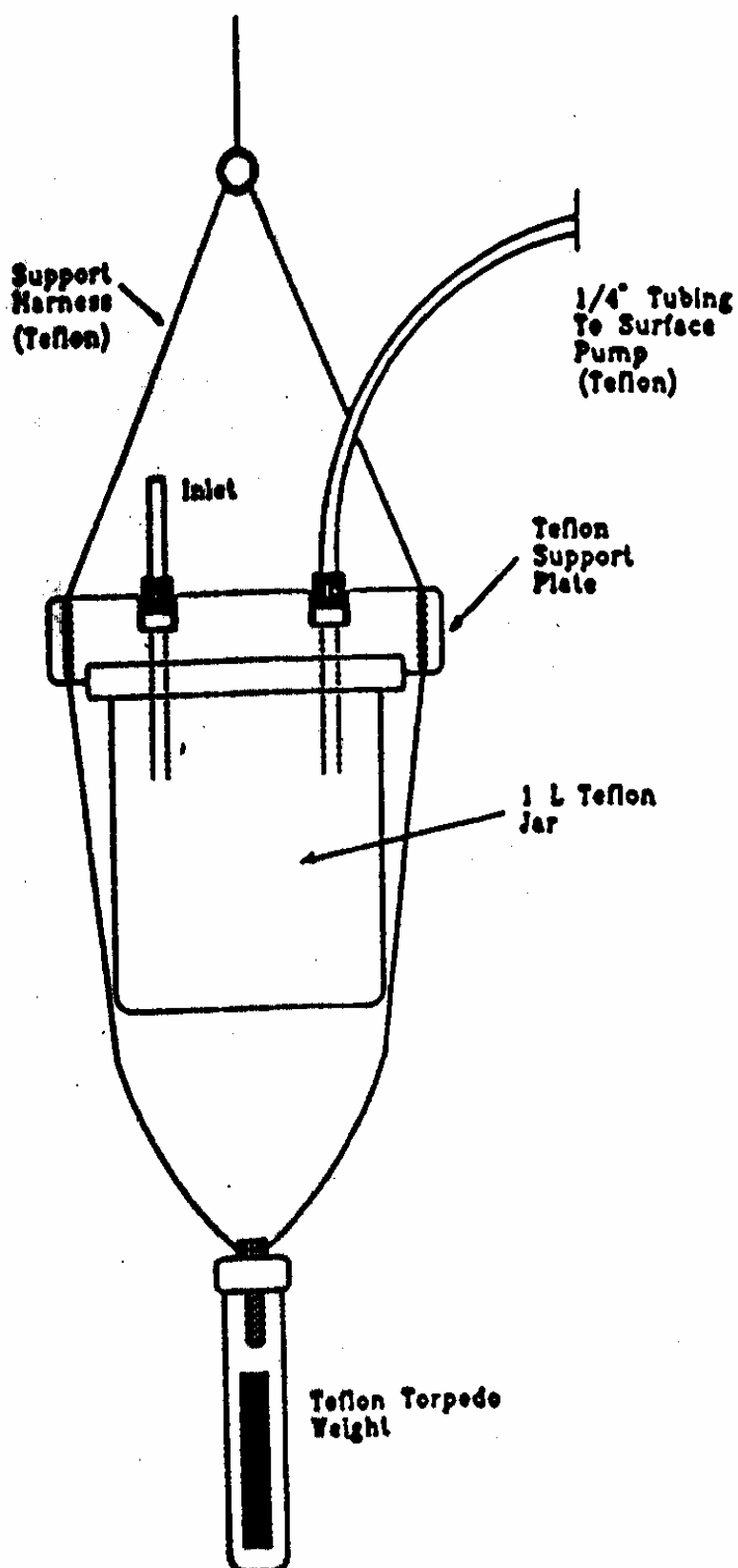


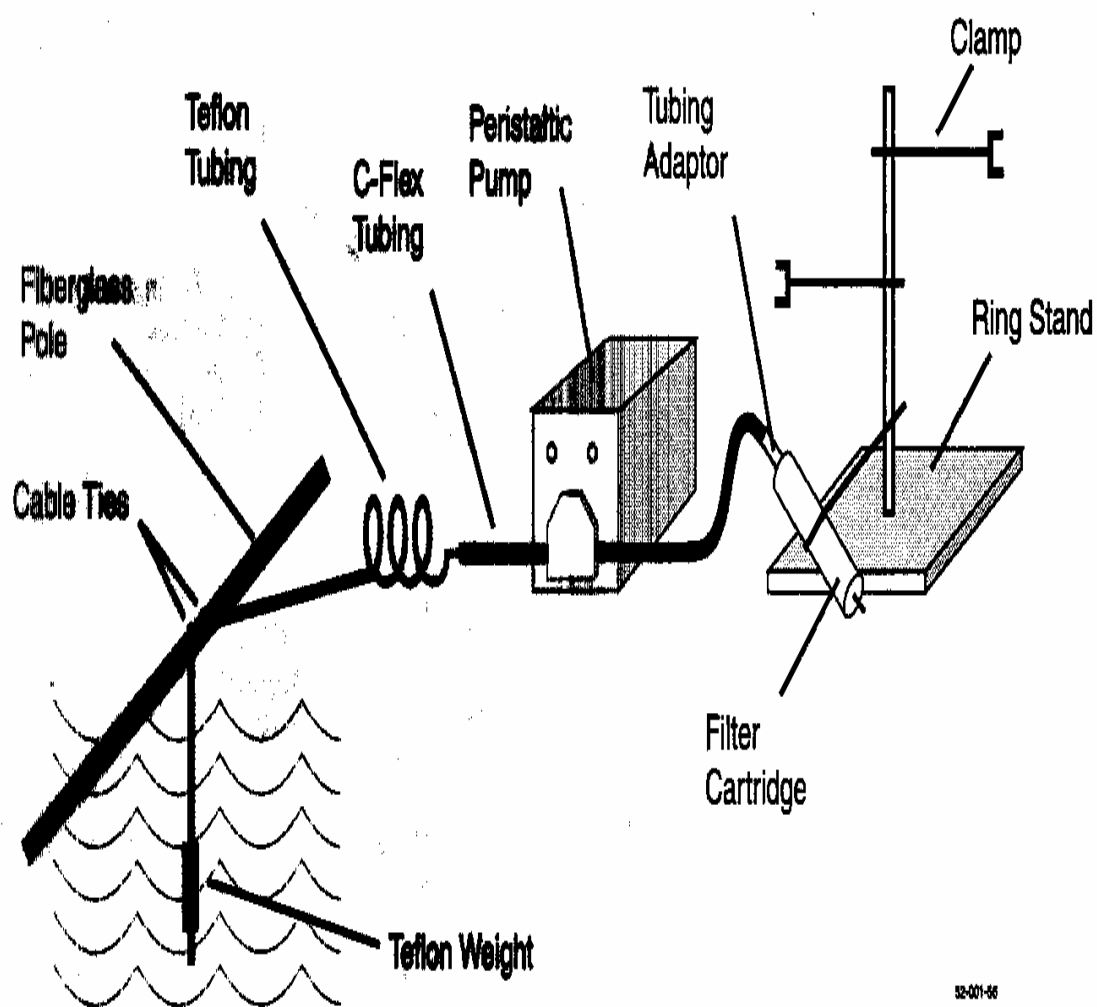
**Figure 1 - Grab Sampling Device**



**Figure 2 - Grab Sampling Device**

**Figure 3 - Jar Sampling Device**



**Figure 4 - Sample Pumping System**

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